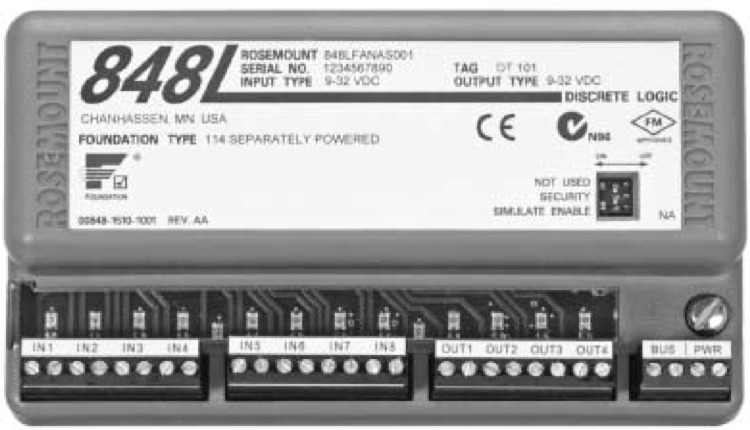
Reference Manual
00809-0100-4696, Rev AA
September 2004

Rosemount 848L Logic Transmitter with FOUNDATION™ Fieldbus

Product Discontinued



FOUNDATION

ROSEMOUNT

www.rosemount.com

EMERSON Process Management

Rosemount 848L Discrete Logic Temperature Transmitter with FOUNDATION Fieldbus

NOTICE

Read this manual before working with the product. For personal and system safety, and for optimum product performance, make sure to thoroughly understand the contents before installing, using, or maintaining this product.

The United States has two toll-free assistance numbers and one international number.

Customer Central
1-800-999-9307 (7:00 a.m. to 7:00 P.M. CST)

National Response Center
1-800-654-7768 (24 hours a day)
Equipment service needs

International
1-(952) 906-8888

⚠CAUTION

The products described in this document are NOT designed for nuclear-qualified applications.

Using non-nuclear qualified products in applications that require nuclear-qualified hardware or products may cause inaccurate readings.

For information on Rosemount nuclear-qualified products, contact a Emerson Process Management Sales Representative.

Cover photo: 848-848C004

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Section 1 Introduction

SAFETY MESSAGES

Instructions and procedures in this section may require special precautions to ensure the safety of the personnel performing the operations. Information that potentially raises safety issues is indicated by a warning symbol (⚠). Please refer to the following safety messages before performing an operation preceded by this symbol.

Warnings

⚠WARNING

Failure to follow these installation guidelines could result in death or serious injury.

- Make sure only qualified personnel perform the installation.

Electrical shock could cause death or serious injury.

- If the device or senors are installed in a high voltage environment and a fault condition or installation error occurs, high voltage may be present on transmitter leads and terminals.
- Use extreme caution when making contact with the leads and terminals.

OVERVIEW

Transmitter

The 848L provides a cost effective field mounted interface for discrete inputs and outputs on a Foundation Fieldbus H1 network. The 848L allows you to leverage the fieldbus network to reduce discrete input and output wiring and eliminate the need for a separate bus for discrete inputs and outputs. The 848L can communicate with other devices on the segment to provide logic interactions independent of any upper level controller.

The 848L also has logic capability allowing it to independently control outputs based on the state of one or more of it's inputs or discrete signals from other devices on the network. A Logic Block allows for up to 20 Boolean equations, 8 Inputs, and 4 Outputs.

Manual

This manual is designed to assist in the installation, operation, and maintenance of the Rosemount 848L Logic Transmitter.

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RETURN OF MATERIALS

To expedite the return process in North America, call the Emerson Process Management National Response Center toll-free at 800-654-7768. This center, available 24 hours a day, will assist with any needed information or materials.

⚠ The center will ask for the following information:

- Product model
- Serial numbers
- The last process material to which the product was exposed

The center will provide

- A Return Material Authorization (RMA) number
- Instructions and procedures that are necessary to return goods that were exposed to hazardous substances

For other locations, please contact an Emerson Process Management sales representative.

NOTE
If a hazardous substance is identified, a Material Safety Data Sheet (MSDS), required by law to be available to people exposed to specific hazardous substances, must be included with the returned materials.

Section 2 Installation

SAFETY MESSAGES

Instructions and procedures in this section may require special precautions to ensure the safety of the personnel performing the operations. Information that potentially raises safety issues is indicated by a warning symbol (⚠). Please refer to the following safety messages before performing an operation preceded by this symbol.

Warnings

⚠WARNING

Failure to follow these installation guidelines could result in death or serious injury.

- Make sure only qualified personnel perform the installation.

Electrical shock could cause death or serious injury.

- If the device or sensors are installed in a high voltage environment and a fault condition or installation error occurs, high voltage may be present on transmitter leads and terminals.
- Use extreme caution when making contact with the leads and terminals.

MOUNTING

The 848L is always mounted remote from the sensors and output devices. There are three mounting configurations:

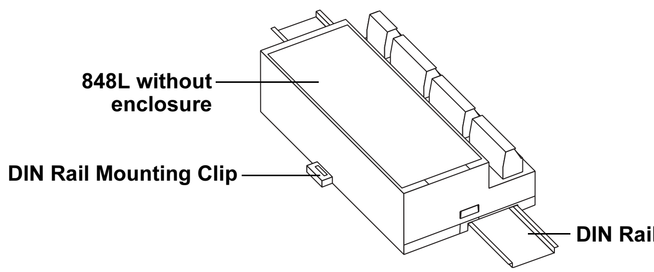
- To a DIN rail without an enclosure
- To a panel with an enclosure
- To a 2-in pipe stand with an enclosure using a pipe mounting kit

Mounting to a DIN Rail Without an Enclosure

To mount the 848L to a DIN rail without an enclosure, follow these steps:

1. Pull up the DIN rail mounting clip located on the top back side of the transmitter.
2. Hinge the DIN rail into the slots on the bottom of the transmitter.
3. Tilt the 848L and place onto the DIN rail. Release the mounting clip. The transmitter should be securely fastened to the DIN rail.

Figure 2-1. Mounting the 848L to a DIN Rail

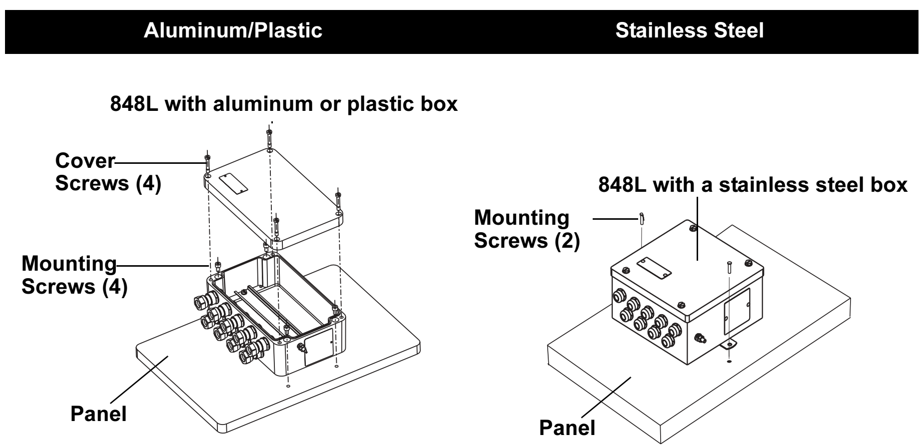


Mounting to a Panel with a Junction Box

When inside of a plastic or aluminum junction box, the 848L mounts to a panel using four $^{1}/_{4}$-20 x 1.25-in. screws.

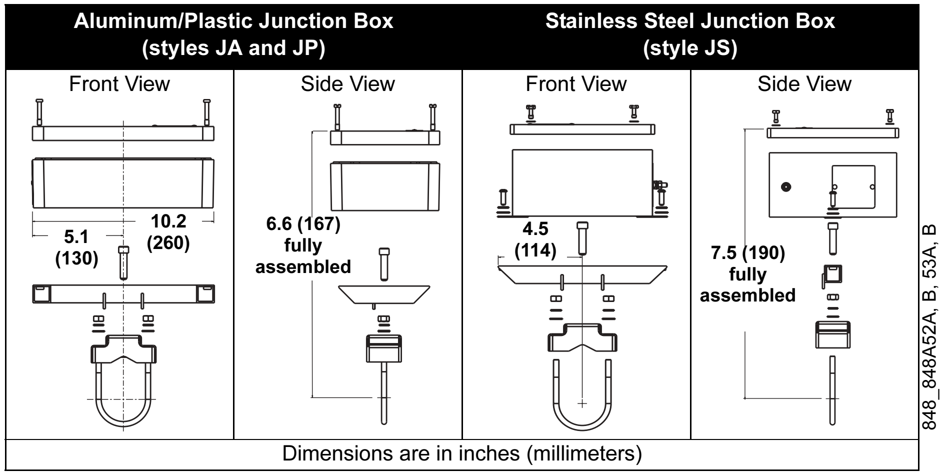
When inside of a stainless steel junction box, the 848L mounts to a panel using two $^{1}/_{4}$-20 x $^{1}/_{2}$-in. screws.

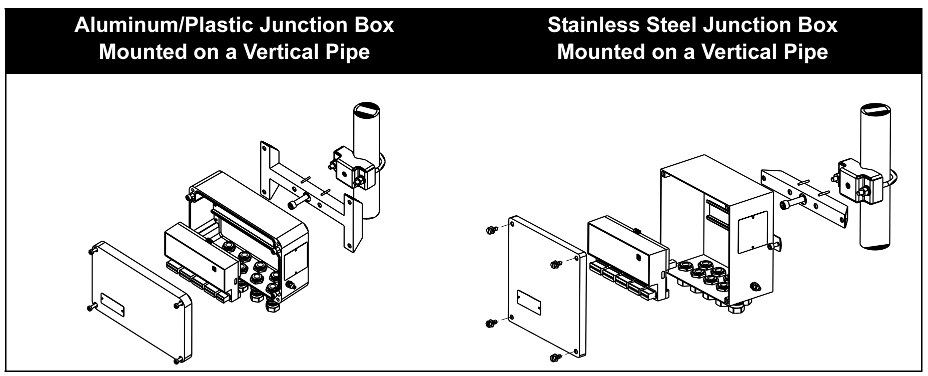
Figure 2-2. Mounting the 848L junction box to a panel



Mounting to a 2-Inch Pipe Stand

Use the optional mounting bracket (option code B6) to mount the 848L to a 2-inch pipe stand when using a junction box.



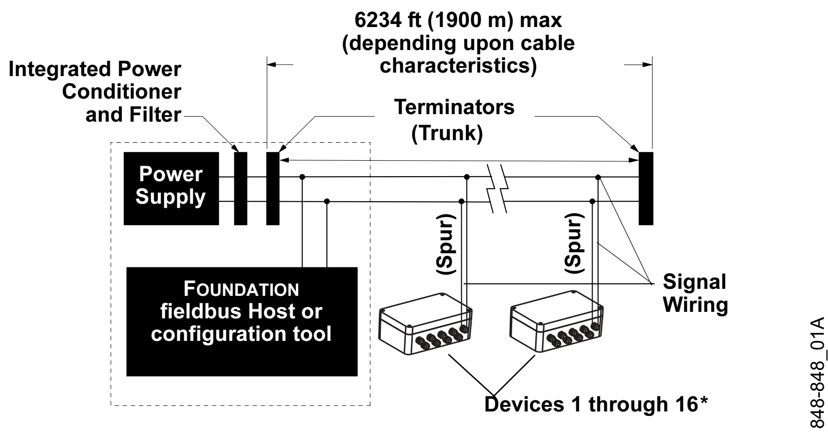


WIRING

⚠ If the device or sensors are installed in a high-voltage environment and a fault condition or installation error occurs, the sensor leads and transmitter terminals could carry lethal voltages. Use extreme caution when making contact with the leads and terminals.

NOTE
Do not apply high voltage (e.g. AC line voltage) to the transmitter bus or I/O power terminals. Abnormally high voltage can damage the unit (bus and I/O power terminals are rated to 42.4 VDC).

Figure 2-3. 848L Transmitter Fieldbus Wiring



Power Supply Connections

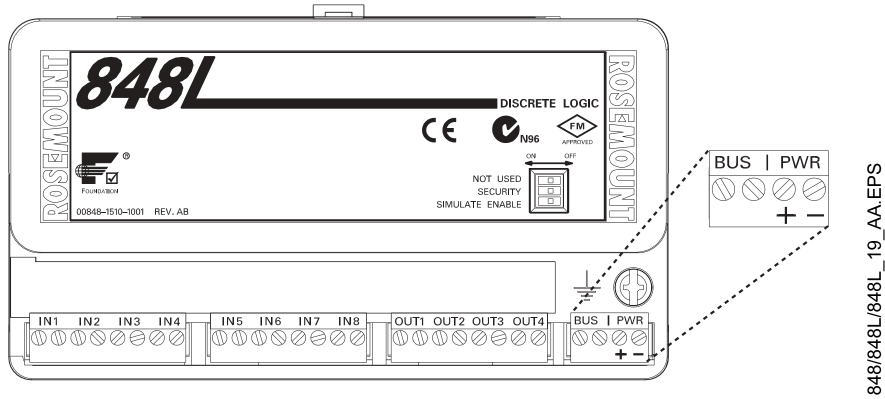
The transmitter requires both a fieldbus connection and power for the discrete I/O channels.

Fieldbus Connection

The fieldbus connection requires between 9 and 32VDC to operate the electronics. The dc power supply should provide power with less than 2% ripple. A fieldbus segment requires a power conditioner to isolate the power supply filter and decouple the segment from other segments attached to the same power supply. Signal wiring should be shielded, twisted pair for best results in electrically noisy environments. Do not use unshielded signal wiring in open trays with power wiring or near heavy electrical equipment. Use ordinary copper wire of sufficient size to ensure that the voltage across the bus terminals does not go below 9 VDC. The power terminals are not polarity sensitive. To power the electronics and establish communications:

1. Connect the fieldbus wires to the terminals marked "Bus" as shown in Figure 2-4 on page 2-5.
2. Tighten the terminal screws to ensure adequate contact.

Figure 2-4. “Bus” location on the Rosemount 848L



Input/Output Power:

The discrete I/O requires a 9-32VDC power supply that is separate from the fieldbus power. The voltage level will depend on the type of sensors being used and outputs being driven. To power the I/O:

1. Connect the positive lead from the power supply to the (+) terminal marked "PWR".
2. Connect the return lead to the (-) terminal marked "PWR"
3. Tighten the terminal screws to ensure adequate contact.

⚠Surges/Transients

The transmitter will withstand electrical transients encountered through static discharges or induced switching transients. However, a transient protection option (option code T1) is available to protect the 848L against high-energy transients. The device must be properly grounded using the ground terminal.

GROUNDING

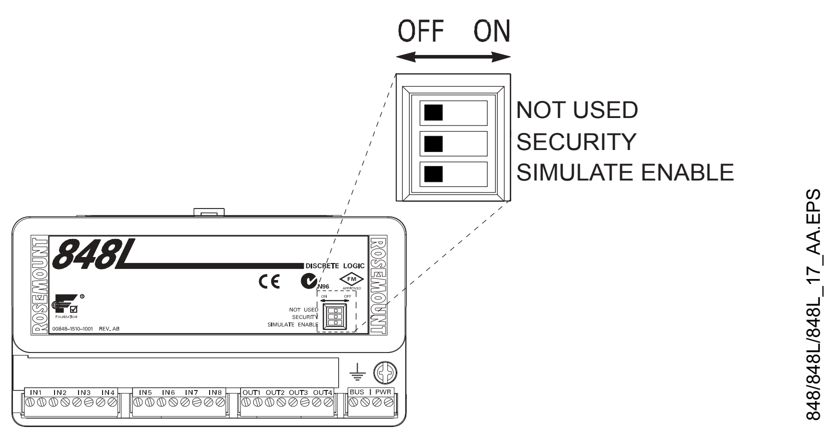
Although not required, a ground terminal is provided that can be connected to earth ground for optimal EMC performance. A wire of 14AWG or larger is recommend using appropriate terminal connectors at both ends.

Transmitter Enclosure (optional)

Ground the transmitter in accordance with local electrical requirements.

SWITCHES

Figure 2-5. Switch Location on the Rosemount 848L



Security

After configuring the transmitter, the data can be protected from unwarranted changes. Each 848L is equipped with a security switch that can be positioned “ON” to prevent the accidental or deliberate change of configuration data. This switch is located on the front side of the electronics module and is labeled SECURITY.

See Figure 2-5 on page 2-5 for switch location on the transmitter label. Refer to Section 3: Configuration, “SOFT WRITE LOCK and HARD WRITE LOCK” on page 3-5.

Simulate Enable

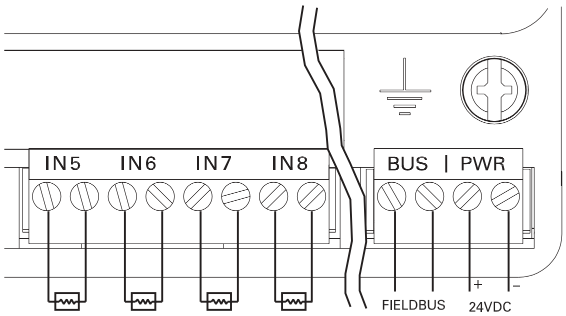
The switch labeled SIMULATE ENABLE is used in conjunction with the with the Discrete Input (DI) and Discrete Output (DO) function blocks. This switch is used to simulate input status. As a lock-out feature, the switch must transition from “OFF” to “ON” after power is applied to the transmitter. This feature prevents the transmitter from being left in simulator mode.

NOT USED

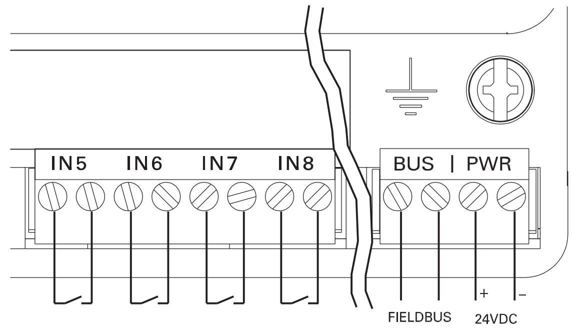
The switch labeled NOT USED is only used for product engineering and development purposes and should always remain in the “OFF” position. If the switch is turned to the “ON” position and power is applied, the 848L will not be present on the fieldbus segment.

I/O WIRING

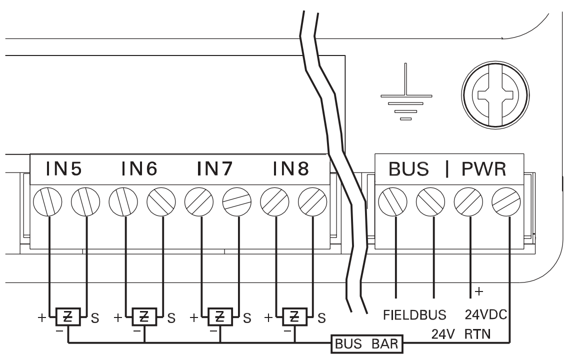
DISCRETE INPUT WIRING CONFIGURATION



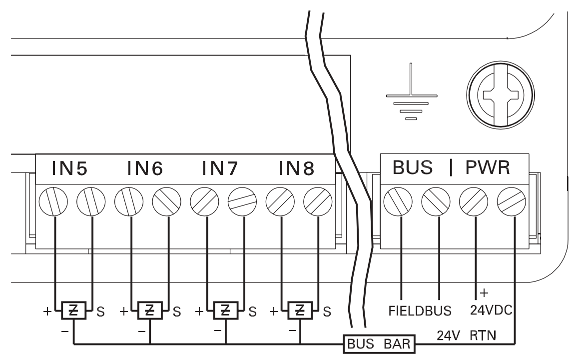
2-Wire NAMUR Sensors
1 of 2 Input Connectors



Dry Contact Switches
1 of 2 Input Connectors

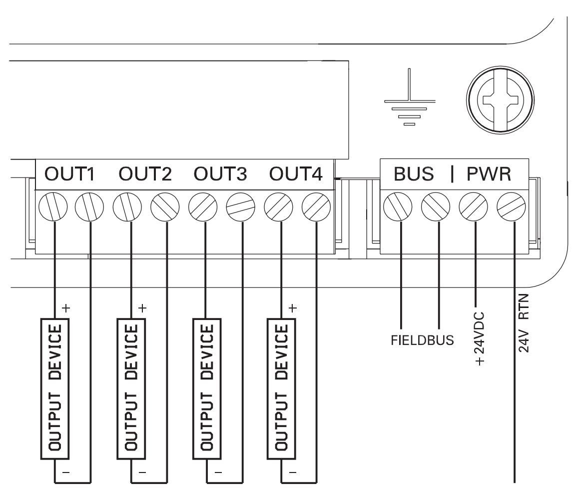


3-Wire NAMUR Sensors
1 of 2 Input Connectors



9-32 VDC Sensors
1 of 2 Input Connectors

DISCRETE OUTPUT WIRING CONFIGURATION



9-32 VDC Outputs

848/848L/848L_10_AA, 848L_11_AA, 848L_12_AA, 848L_13_AA, 848L_14_AA.EPS

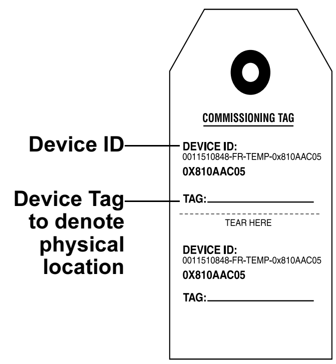
TAGGING

Commissioning Tag

The 848L is supplied with a removable commissioning tag that contains both the Device ID (the unique code that identifies a particular device in the absence of a device tag) and a space to record the device tag (the operational identification for the device as defined by the Piping and Instrumentation Diagram (P&ID)).

When commissioning more than one device on a fieldbus segment, it can be difficult to identify which device is at a particular location. The removable tag, provided with the transmitter, can aid in this process by linking the Device ID to its physical location. The installer should note the physical location of the transmitter on both the upper and lower location of the commissioning tag. The bottom portion should be torn off for each device on the segment and used for commissioning the segment in the control system.

Figure 2-6. Commissioning Tag



Transmitter Tag

Hardware

- tagged in accordance with customer requirements
- permanently attached to the transmitter

Software

- the transmitter can store up to 30 characters
- if no characters are specified, the first 30 characters of the hardware tag will be used

Sensor Tag

Hardware

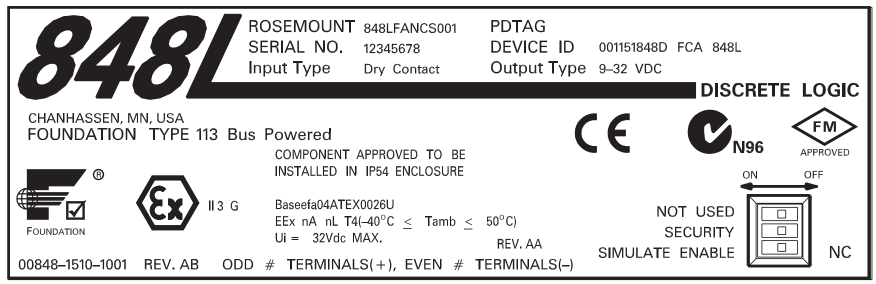
- a plastic tag is provided to record identification of the I/O
- in the field, the tag can be removed, printed on, and reattached to the transmitter

Software

- the I/O Transducer Block provides the ability to record the I/O tags.

TRANSMITTER LABEL

Figure 2-7. Transmitter Label



848/848_21_AA.EPS

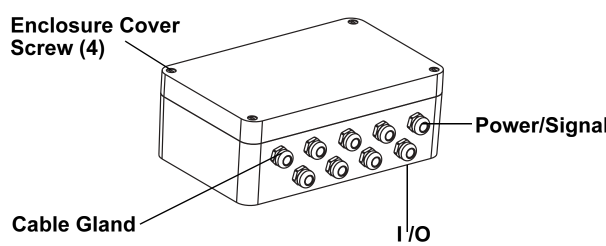
INSTALLATION

Using Cable Glands

Use the following steps to install the 848L with Cable Glands:

1. Remove the junction box cover by unscrewing the four cover screws.
2. Run the sensor and power/signal wires through the appropriate cable glands using the pre-installed cable glands (see Figure 2-8).
3. Install the I/O wires into the correct screw terminals.
4. Install the power/signal wires onto the correct screw terminals. Bus power is polarity insensitive, allowing the user to connect positive (+) or negative (–) to either Fieldbus wiring terminal labeled “Bus.” I/O power is polarity sensitive and must be connected correctly to avoid damage to the transmitter. See Figure 2-4 on page 2-5.
5. Replace the enclosure cover and securely tighten all cover screws.

Figure 2-8. Installing the 848L with Cable Glands



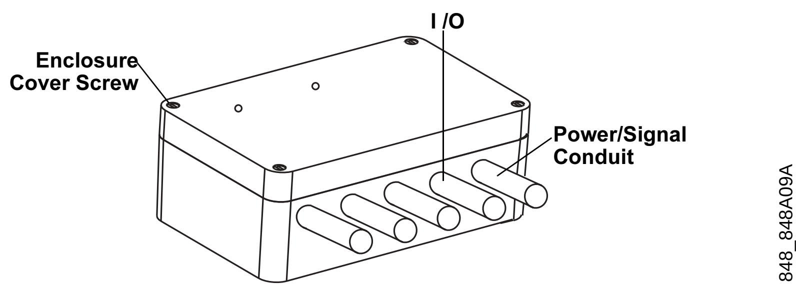
848_848A19A

Using Conduit Entries

Use the following steps to install the 848L with Conduit Entries:

1. Remove the junction box cover by unscrewing the four cover screws.
2. Remove the five conduit plugs and install five conduit fittings (supplied by the installer).
3. Run sensor and output wires through each conduit fitting.
4. Install the I/O wires into the correct screw terminals.
5. Install the power/signal wires into the correct screw terminals. Bus power is polarity insensitive, allowing the user to connect positive (+) or negative (–) to either Fieldbus wiring terminal labeled “Bus.” I/O power is polarity sensitive and must be connected correctly to avoid damage to the transmitter. See Figure 2-4 on page 2-5.
6. Replace the junction box cover and securely tighten all cover screws.

Figure 2-9. Installing the 848L with Conduit Entries



Section 3 Configuration

OVERVIEW

This section covers basic operation, software functionality, and basic configuration procedures for the Rosemount 848L transmitter with FOUNDATION fieldbus. This section is organized by block information. For detailed information about the function blocks used in the Rosemount 848L logic transmitter, refer to “Foundation Fieldbus Block Information” on page A-1 and the Foundation Fieldbus Function Block manual (00809-0100-4783).

SAFETY MESSAGES

Procedures and instructions in this section may require special precautions to ensure the safety of the personnel performing the operations. Information that raises potential safety issues is indicated by a warning symbol (⚠). Refer to the following safety messages before performing an operation preceded by this symbol.

Warnings

⚠WARNING

Explosions can result in death or serious injury.

Before connecting a configuration tool in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with nonincendive field wiring practices.

⚠WARNING

Electrical shock can result in death or serious injury.

- Avoid contact with the leads and terminals. High voltage that may be present on leads can cause electrical shock.

GENERAL BLOCK INFORMATION

Modes

The Resource, Transducer, and all function blocks in the device have modes of operation. These modes govern the operation of the block. Every block supports both automatic (AUTO) and out of service (OOS) modes. Other modes may also be supported.

⚠ **Changing Modes**

To change the operating mode, set the MODE_BLK.TARGET to the desired mode. After a short delay, the parameter MODE_BLOCK.ACTUAL should reflect the mode change if the block is operating properly.

Permitted Modes

It is possible to prevent unauthorized changes to the operating mode of a block. To do this, configure MODE_BLOCK.PERMITTED to allow only the desired operating modes. It is recommended to always select OOS as one of the permitted modes.

Types of Modes

For the procedures described in this manual, it will be helpful to understand the following modes:

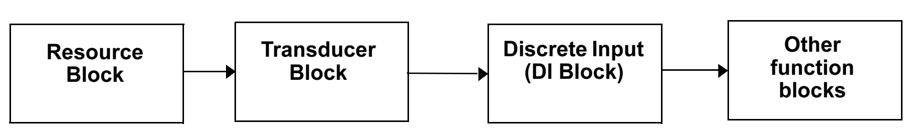
AUTO
The functions performed by the block will execute. If the block has any outputs, these will continue to update. This is typically the normal operating mode.

Out of Service (OOS)
The functions performed by the block will not execute. If the block has any outputs, these will typically not update and the status of any values passed to downstream blocks will be “BAD”. To make some changes to the configuration of the block, change the mode of the block to OOS. When the changes are complete, change the mode back to AUTO.

MAN
In this mode, variables that are passed out of the block can be manually set for testing or override purposes.

Other Types of Modes
Other types of modes are Cas, RCas, ROut, IMan and LO. Some of these may be supported by different function blocks in the Rosemount 848L. For more information, see the Function Block manual, document 00809-0100-4783.

NOTE
When an upstream block is set to OOS, this will impact the output status of all downstream blocks. The figure below depicts the hierarchy of blocks:



Link Active Scheduler

The Rosemount 848L can be designated to act as the backup Link Active Scheduler (LAS) in the event that the LAS is disconnected from the segment. As the backup LAS, the Rosemount 848L will take over the management of communications until the host is restored.

The host system may provide a configuration tool specifically designed to designate a particular device as a backup LAS. Otherwise, this can be configured manually as follows:

1. Access the Management Information Base (MIB) for the Rosemount 848L.
2. To activate the LAS capability, write 0x02 to the BOOT_OPERAT_FUNCTIONAL_CLASS object (Index 605). To deactivate, write 0x01.
3. Restart the processor.

Block Instantiation

Rosemount devices are pre-configured with function blocks at the factory, the default permanent configuration for the Rosemount 848L is listed below. The Rosemount 848L can have one additional instantiated function block.

- 8 Discrete Input Blocks
- 4 Discrete Output Blocks
- Multiple Discrete Input Block
- Multiple Discrete Output Block

The Rosemount 848L supports the use of Function Block Instantiation. When a device supports block instantiation, the number of blocks and block types can be defined to match specific application needs.The number of blocks that can be instantiated is only limited by the amount of memory within the device and the block types that are supported by the device. Instantiation does not apply to standard device blocks like the Resource, I/O Transducer, and Logic Transducer Block.

Block instantiation is done by the host control system or configuration tool, but not all hosts are required to implement this functionality. Please refer to your specific host or configuration tool manual for more information.

Capabilities

Virtual Communication Relationship (VCRs)

There are a total of 20 VCRs. Two are permanent and 18 are fully configurable by the host system. 25 link objects are available.

Network Parameter	Value
Slot Time	8
Maximum Response Delay	4
Maximum Inactivity to Claim LAS Delay	60
Minimum Inter DLPDU Delay	7
Time Sync class	4 (1ms)
Maximum Scheduling Overhead	21
Per DLPDU PhL Overhead	4
Maximum Inter-channel Signal Skew	0
Required Number of Post-transmission-gap-ext Units	0
Required Number of Preamble-extension Units	1

Host timer recommendations

T1 = 96000
T2 = 1920000
T3 = 480000

Block Execution times

Discrete Input = 40 ms
Discrete Output = 40 ms
Multiple Discrete Input = 40 ms
Multiple Discrete Output = 40 ms

RESOURCE BLOCK

FEATURES and FEATURES_SEL

The parameters FEATURES and FEATURE_SEL determine optional behavior of the Rosemount 848L.

FEATURES

The FEATURES parameter is read only and defines which features are supported by the Rosemount 848L. Below is a list of the FEATURES the Rosemount 848L supports.

UNICODE

All configurable string variables in the Rosemount 848L, except tag names, are octet strings. Either ASCII or Unicode may be used. If the configuration device is generating Unicode octet strings, you must set the Unicode option bit.

REPORTS

The Rosemount 848L supports alert reports. The Reports option bit must be set in the features bit string to use this feature. If it is not set, the host must poll for alerts.

SOFT WRITE LOCK and HARD WRITE LOCK

Inputs to the security and write lock functions include the hardware security switch, the hardware and software write lock bits of the FEATURE_SEL parameter, the WRITE_LOCK parameter, and the DEFINE_WRITE_LOCK parameter.

The WRITE_LOCK parameter prevents modification of parameters within the device except to clear the WRITE_LOCK parameter. During this time, the block will function normally updating inputs and outputs and executing algorithms. When the WRITE_LOCK condition is cleared, a WRITE_ALM alert is generated with a priority that corresponds to the WRITE_PRI parameter.

The FEATURE_SEL parameter enables the user to select a hardware or software write lock or no write lock capability. To enable the hardware security function, enable the HW_SEL bit in the FEATURE_SEL parameter. When this bit has been enabled the WRITE_LOCK parameter becomes read only and will reflect the state of the hardware switch. In order to enable the software write lock, the SW_SEL bit must be set in the FEATURE_SEL parameter. Once this bit is set, the WRITE_LOCK parameter may be set to “Locked” or “Not Locked.” Once the WRITE_LOCK parameter is set to “Locked” by either the software or the hardware lock, all user requested writes as determined by the DEFINE_WRITE_LOCK parameter shall be rejected.

The DEFINE_WRITE_LOCK parameter allows the user to configure whether the write lock functions (both software and hardware) will control writing to all blocks, or only to the resource and transducer blocks. Internally updated data such as process variables and diagnostics will not be restricted by the security switch.

The following table displays all possible configurations of the WRITE_LOCK parameter.

FEATURE_SEL HW_SEL bit	FEATURE_SEL SW_SEL bit	SECURITY SWITCH	WRITE_LOCK	WRITE_LOCK Read/Write	DEFINE_WRITE_LOCK	Write access to blocks
0 (off)	0 (off)	NA	1 (unlocked)	Read only	NA	All
0 (off)	1 (on)	NA	1 (unlocked)	Read/Write	NA	All
0 (off)	1 (on)	NA	2 (locked)	Read/Write	Physical	Function Blocks only
0 (off)	1 (on)	NA	2 (locked)	Read/Write	Everything	None
1 (on)	0 (off)(1)	0 (unlocked)	1 (unlocked)	Read only	NA	All
1 (on)	0 (off)	1 (locked)	2 (locked)	Read only	Physical	Function Blocks only
1 (on)	0 (off)	1 (locked)	2 (locked)	Read only	Everything	None

(1) The hardware and software write lock select bits are mutually exclusive and the hardware select has the highest priority. When the HW_SEL bit if set to 1 (on), the SW_SEL bit is automatically set to 0 (off) and is read only.

FEATURE_SEL

FEATURE_SEL is used to turn on any of the supported features. The default setting of the Rosemount 848L does not select any of these features. Choose one of the supported features if any.

MAX_NOTIFY

The MAX_NOTIFY parameter value is the maximum number of alert reports that the resource can have sent without getting a confirmation, corresponding to the amount of buffer space available for alert messages. The number can be set lower, to control alert flooding, by adjusting the LIM_NOTIFY parameter value. If LIM_NOTIFY is set to zero, then no alerts are reported.

PlantWeb™ Alarms

The Resource Block will act as a coordinator for PlantWeb alarms. There will be three alarm parameters (FAILED_ALARM, MAINT_ALARM, and ADVISE_ALARM) which will contain information regarding some of the device errors which are detected by the transmitter software. There will be a RECOMMENDED_ACTION parameter which will be used to display the recommended action text for the highest priority alarm. FAILED_ALARM will have the highest priority followed by MAINT_ALARM and ADVISE_ALARM will be the lowest priority.

FAILED_ALARMS

A failure alarm indicates a failure within a device that will make the device or some part of the device non-operational. This implies that the device is in need of repair and must be fixed immediately. There are five parameters associated with FAILED_ALARMS specifically, they are described below.

FAILED_ENABLED
This parameter contains a list of failures in the device which makes the device non-operational that will cause an alarm to be sent. Below is a list of the failures with the highest priority first.

1. Electronics Failure
2. NV Memory Failure
3. No I/O Power
4. Primary Value Failure
5. Secondary Value Failure

FAILED_MASK
This parameter will mask any of the failed conditions listed in FAILED_ENABLED. A bit on means that the condition is masked out from alarming and will not be reported.

FAILED_PRI
Designates the alarming priority of the FAILED_ALM. The default is 0 and the recommended value is between 8 and 15.

FAILED_ACTIVE
This parameter displays which of the alarms is active. Only the alarm with the highest priority will be displayed. This priority is not the same as the FAILED_PRI parameter described above. This priority is not user configurable.

FAILED_ALM
Alarm indicating a failure within a device which makes the device non-operational.

MAINT_ALARMS

A maintenance alarm indicates the device or some part of the device needs maintenance soon. If the condition is ignored, the device will eventually fail. There are five parameters associated with MAINT_ALARMS, they are described below.

MAINT_ENABLED
The MAINT_ENABLED parameter contains a list of conditions indicating the device or some part of the device needs maintenance soon. If the condition is ignored, the device will eventually fail.

Below is a list of the conditions with the highest priority first.

1. Secondary Value Degraded
2. Configuration Error

MAINT_MASK
The MAINT_MASK parameter will mask any of the failed conditions listed in MAINT_ENABLED. A bit on means that the condition is masked out from alarming and will not be reported.

MAINT_PRI
MAINT_PRI designates the alarming priority of the MAINT_ALM. The default is 0 and the recommended value is 3 to 7.

MAINT_ACTIVE
The MAINT_ACTIVE parameter displays which of the alarms is active. Only the condition with the highest priority will be displayed. This priority is not the same as the MAINT_PRI parameter described above. This priority is not user configurable.

MAINT_ALM
An alarm indicating the device needs maintenance soon. If the condition is ignored, the device will eventually fail.

Advisory Alarms

An advisory alarm indicates informative conditions that do not have a direct impact on the device's primary functions There are five parameters associated with ADVISE_ALARMS, they are described below.

ADVISE_ENABLED
The ADVISE_ENABLED parameter contains a list of informative conditions that do not have a direct impact on the device's primary functions. Below is a list of the advisories with the highest priority first.

1. Prescaler Overflow
2. NV Write Deferred
3. PWA Simulate Active

ADVISE_MASK
The ADVISE_MASK parameter will mask any of the failed conditions listed in ADVISE_ENABLED. A bit on means the condition is masked out from alarming and will not be reported.

ADVISE_PRI
ADVISE_PRI designates the alarming priority of the ADVISE_ALM. The default is 0 and the recommended value is 1 or 2.

ADVISE_ACTIVE
The ADVISE_ACTIVE parameter displays which of the advisories is active. Only the advisory with the highest priority will be displayed. This priority is not the same as the ADVISE_PRI parameter described above. This priority is not user configurable.

ADVISE_ALM
ADVISE_ALM is an alarm indicating advisory alarms. These conditions do not have a direct impact on the process or device integrity.

Recommended Actions for PlantWeb Alarms

RECOMMENDED_ACTION
The RECOMMENDED_ACTION parameter displays a text string that will give a recommended course of action to take based on which type and which specific event of the PlantWeb alarms is active.

Table 3-1. RB.RECOMMENDED_ATION

Alarm Type	Failed/Maint/Advise Active Event	Recommended Action Text String
NONE	None	No action required
ADVISORY	Prescaler Overflow	Check the Divisor parameter of all PS function calls in the logic equations
	NV Write Deferred	Reduce the frequency in which applications write to NV Memory
	PWA Simulate Active	Disable PWA_SIMULATE parameter in the Resource Block
MAINTENANCE	Secondary Value Degraded	Ensure that the transmitter is not too close to extreme hot or cold environments
	Configuration Error	Verify that the Logic equations are correct in the Logic transducer block
FAILED	Electronics Failure	Replace the electronics
	NV Memory Failure	Replace the electronics
	No I/O Power	Check the IO Power supply, polarity, wiring, and connections.
	Primary Value Failure	Check the sensor, configuration, wiring, and connection for open or shorted sensors.
	Secondary Value Failure	Verify that the body temperature is within the operating limits of this device.

Alarms

Use the following steps to configure the alarms, which are located in the Resource Block.

1. Set the resource block to OOS.
2. Set WRITE_PRI to the appropriate alarm level (WRITE_PRI has a selectable range of priorities from 0 to 15. Set the other block alarm parameters at this time.
3. Set CONFIRM_TIME to the time, in $^1/_{32}$ of a millisecond, that the device will wait for confirmation of receiving a report before trying again (the device does not retry if CONFIRM_TIME is 0).
4. Set LIM_NOTIFY to a value between zero and MAX_NOTIFY. LIM_NOTIFY is the maximum number of alert reports allowed before the operator needs to acknowledge an alarm condition.
5. Enable the reports bit in FEATURE_SEL.
6. Set the resource block to AUTO.

I/O TRANSDUCER BLOCK

The 848L is ordered with either Dry Contact, VDC or NAMUR Inputs. Each input can have a filter which determines the minimum time a contact needs to be at a given state to be acknowledged as a state change.

The following procedure allows the sensors to be configured:

1. Set MODE_BLK.TARGET to OOS
2. For each Input “n” select the parameter IN_n_CONFIG.FILTER
   a. Select the desired filter time in the range of 0 to 128msec
3. Set MODE_BLK.TARGET to AUTO

The 848L can force the outputs to a predetermined state in the event of a device malfunction.

The following procedure can be used to set the fail safe condition for each output:

1. Set MODE_BLK.TARGET to OOS
2. For each Output "n" select the parameter OUT_n_CONFIG.FAIL_SAFE
3. Select False, True or Last Good Value
4. Set MODE_BLK.TARGET to AUTO

Latching

Most often the inputs are scanned and the logic equations processed at a rate greater than the macrocycle frequency. To be certain that positive or negative transitions are communicated, the inputs, equation results, and output values can be latched until read by the function blocks.

The following procedure is used to set the latching state of each input, equation or output:

1. Set MODE_BLK.TARGET to OOS
2. Select the appropriate parameter for either inputs, equations, or outputs:
   a. Inputs use parameter MACRO_IN_LATCH
   b. Outputs use parameter MACRO_OUT_LATCH
   c. Equations use parameter MACRO_EQ_LATCH

For each input, output or equation select either "Latch Positive Pulses" or "Latch Negative Pulses" or “disabled”.

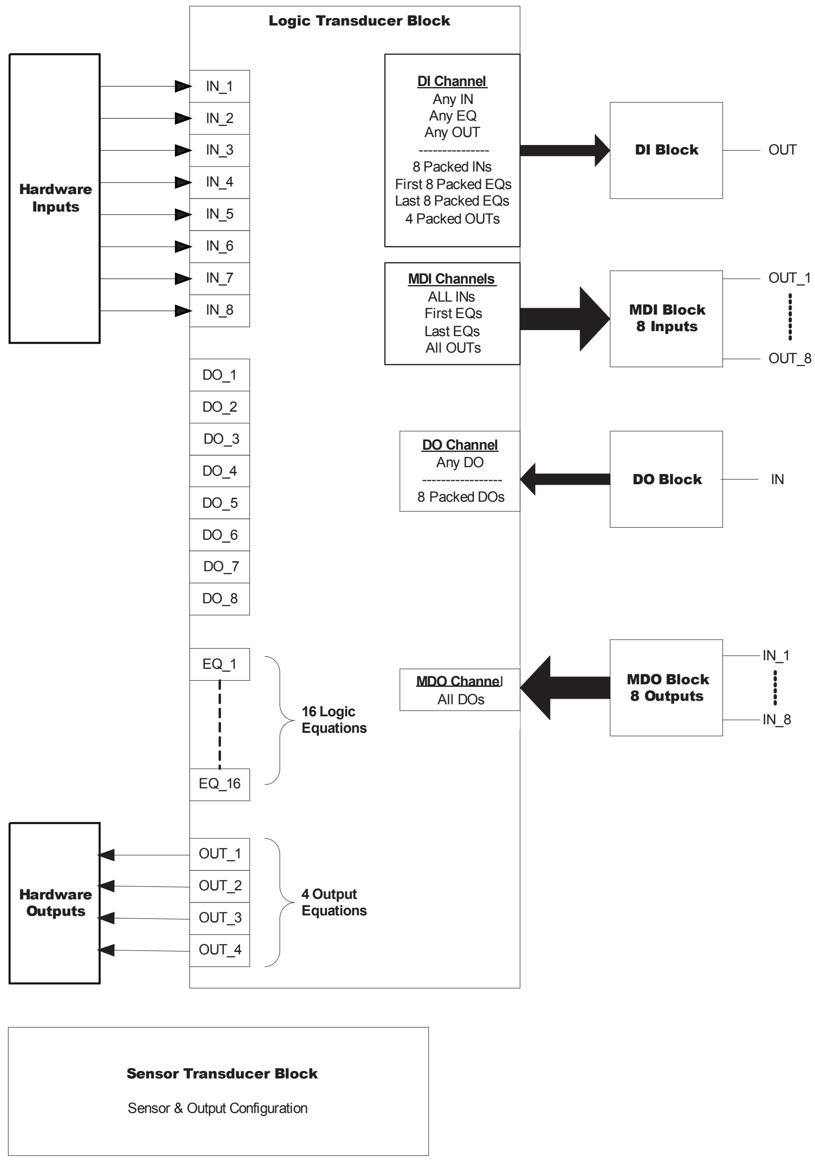
LOGIC TRANSDUCER BLOCK

Logic Equations

The 848L provides for 16 Logic Equations and 4 Output Equations. The Output Equations drive the hardware outputs. Each logic equation consists of up to 80 characters with a semicolon as the last character. The equations are evaluated at a nominal rate of 100msec. However this will vary based on the number and complexity of the equations used. The logic block consists of variables that are connected to the hardware I/O, obtain values or send values over the bus and internally calculated variables as shown in Figure 3-1.

The value or state of the logic block variables can be communicated on the bus by assigning the appropriate channel number of a DI or MDI block. The DO variables can be set externally by assigning the appropriate channel number in a DO or MDO function block. The DO function blocks do not drive the outputs directly. The DO function block can drive the output by referencing the appropriate DO variable in the output equations.

Figure 3-1. 848L Logic Transmitter Data Flow



The following characters are allowed in a logic equation:

- Uppercase and lowercase alphabet, case insensitive, used to specify functions
- Digits 0-9, used to specify channel numbers and unsigned integer constants
- Comma, used to separate parameters in a function parameter list
- Parentheses() used to define the extent of the parameter list of a function
- Semicolon; used to terminate an equation
- Space (not tab), ignored by parser, may be used to make an equation more readable but counts as a character

The following characters are specifically not allowed in a logic:

- The period (dot) character is not allowed. There are no decimal numbers.
- The unary minus (-) character is not allowed. There are no negative integers.
- The math operators (+, -, *, /, **) are not allowed, nor are symbols for any logic operators (&, |, <, >, ...).

Functions must be from the list of Logic Functions below, and must have the specified number of parameters.

Channel Functions

The following functions read channel value and status. The number of instances of these functions is unlimited, except for PS. A channel value and status is set by the I/O processor at the beginning of an equation evaluation cycle, by the equations as they complete evaluation, or by macrocycle evaluations of any DO blocks attached to channels 9 through 16. The status of channels 9-16 is always good, even if the DO block has a bad status.

IN - The input hardware sets the values of channels 1-8. Configured DI blocks may specify these channels in order to read the specified hardware input. The value of an input may be referenced in an equation by the **IN (i)** function, where the channel number is placed between the parentheses. The range of ‘i’ is 1 to 8. Multiple references to any channel are allowed.

ICR, ICF - I/O samples are taken every millisecond, which is considerably faster than equation executions. It is possible for an input to turn on and turn off during an equation evaluation cycle, so that it would not be seen by an IN (i) function. Each input has a counter for transitions (rise or fall). A transition is based on the output of the debounce filter, not the raw input. Filtering can be set to zero. The counter is read and cleared at the beginning of each evaluation cycle. The method relies completely on the counter and does not use the latch configuration. The **ICR (i)** function is true for one evaluation cycle if a rising transition occurred, and its opposite **ICF (i)** is true for a falling transition.

PS - When the hardware input consists of a continuous train of pulses at a rate less than 500 PPS, a prescaler can be used to reduce the pulse rate to something that does not change faster than the equation evaluation rate. The function is **PS (i, divisor)** where ‘i’ is the channel number (1-8) and ‘divisor’ is the number of pulses to count before setting its output true for one equation evaluation cycle. The counter rolls over at ‘divisor’ and keeps counting. The user must assure that there is always at least one execution cycle with a false value from PS for every true value. If the pulse rate exceeds the divisor times two, then the function returns Bad status and optionally a PlantWeb alert can be sent. Only ten of these functions are available because they require storage for previous values.

DO - Channels 9-16 are zero unless set by configured DO or MDO function blocks. This allows a function block link to set the value from a remote function block output or HMI screen switch. The values may be referenced in equations by the **DO (d)** function. The range of ‘d’ is 1 to 8. To directly drive an output from an external device the Output Equation would reference DO(d).

NOTE
The value of DO can change during an evaluation cycle if the macrocycle evaluates the DO block. This may require referencing the DO value in a single equation to “save” its state.

EQ - Channels 17-32 are set by the result of an equation specified by up to 80 characters and stored in parameter EQx, where x is the equation number. The equation results are available as a discrete value and status in parameter EQx_VALUE. They may be referenced by the **EQ (u)** function. The range of ‘u’ is 1 to 16. These are intended to be intermediate values that are used because the value is used in other equations or because the equation text was too long. A configured DI block may use an equation channel (range 17 to 36) in order to make the result available to other devices.

OUT – The value will be the same as the requested output.

Additional Channels

The ten channels that are used for connecting multiple in or out function blocks can not be referred to by equation functions. Each has a status that is Bad if any Input status is Bad. Channels 37 to 41 pack the values into one byte so that a DI or DO function block can read or write them. Any block linked to a DI block with packed data must be capable of handling the packed boolean values. Channels 42 to 46 may be used with standard MDI or MDO blocks.

Channel	Type	FB
37	All IN	DI
38	All DO	DO
39	First 8 EQ	DI
40	Last 8 EQ	DI
41	All OUT	DO
42	All IN	MDI
43	All DO	MDO
44	First 8 EQ	MDI
45	Last 8 EQ	MDI
46	All Out	MDO

Reading a channel value will reset all of the channel latches that are configured. Channels 38 and 43 do not have latches. If a DI and a MDI are both used they will interfere with the latches, but the user is expected to use one or the other, never both.

Logic Functions

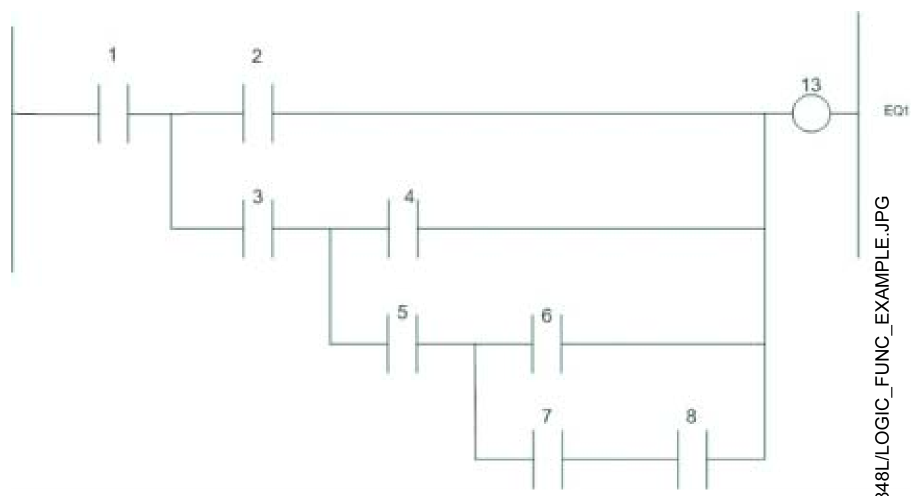
A function has a name and a set of one or more arguments contained within a closed set of parentheses. The seven channel reference functions (IN, ICF, ICR, PS, DO, EQ, and OUT) have been described above. These are the only functions that take a channel number as an argument. The other functions require functions for all arguments unless the last argument is a constant number.

When a function is evaluated, it leaves its true or false value behind to be evaluated by the next function or used as the result of evaluating the equation. This is the result of using a simple and fast evaluation method known as Reverse Polish Notation (RPN). The RPN method requires nesting the functions like OR(IN(1),IN(2)) rather than using operator notation like IN(1) | IN(2). This can lead to the following:

AND(IN(1),OR(IN(2),AND(IN(3),OR(IN(4),AND(IN(5),OR(IN(6),AND(IN(7),(IN(8))))))));

The equation is evaluated by evaluating the deepest functions first, IN(7) and (IN(8). If they are both true then the AND function evaluates to true. Then IN(6) is evaluated, then the OR evaluates to true, and so on working up from the deepest level in reverse order until the first (and top level) AND can be evaluated. The result is stored in the channel specified by EQx, which contains the text of the equation as explained above.

Drawn as a ladder logic, the equation would look like the figure below:



848L/LOGIC_FUNC_EXAMPLE.JPG

Logic Operator Functions

The following combinatorial operators require a minimum of 2 and a maximum of 10 functions between the parentheses, each separated by a comma.

AND ( ) - Performs the logical ‘and’ of the argument functions.

OR ( ) - Performs the logical ‘or’ of the argument functions.

XOR ( ) - Performs the logical exclusive ‘or’ of the argument functions. An XOR function is false if all of the arguments are the same value, either all true or all false. Otherwise it is true.

The following unary operator requires just one argument:

NOT ( ) - Performs the logical inversion of the argument function.

Limits on Functions

There is no limit to the number of functions described above, as long as they fit within the 20 equations described by 80 character strings. The following functions are limited to 10 of each within the entire set of 20 equations. This is because the functions require memory to store constants or last values. The size of a memory element is 16 bits, so the maximum size of a constant value is 65535. There are no signed numbers.

Edge Detection Functions

RISE ( ) - This function evaluates as false unless the previous value of the argument was false and now the argument evaluates to true. This function is true for only one equation evaluation cycle. It will always be false on the following cycle.

FALL( ) - This function evaluates as false unless the previous value of the argument was true and now the argument evaluates to false. This function is true for only one equation evaluation cycle. It will always be false on the following cycle.

Clock Function

NOTE
All arguments of time are in tenths of a second.

CLOCK (onTime,offTime) - The parameters onTime and offTime are constants. This function does not take other functions. CLOCK runs unconditionally with a period determined by onTime plus offTime. Time is specified in tenths of a second. The function will be true for onTime tenths of a second. On the first evaluation cycle after the device starts up, the onTime interval will start because all of the dynamic values are zero. Use the NOT function to invert this behavior, and swap the on and off times.

Counter Functions

CTU (clock, reset, target)- The parameters clock and reset are functions. The target is a 16 bit constant. Whenever reset is true, the internal counter is set to zero and the value of the function is false. The value of clock is ignored while reset is true. If reset is false, the internal counter will increment once for each rise of the clock parameter. When the internal counter equals the target value, the value of the function is true and the counter stops counting in order to avoid rollover. The value of the function is false if the internal counter does not equal the target.

The internal counter is not visible from Fieldbus and is not available to any other function. The value of the internal counter is not retained during a device restart. This function is not suitable for a totalizer, but can be used as a prescaler to adjust the external mechanical counter rate. The pulse rate must be less than five per second.

The following expression increments the counter whenever hardware input 1 turns on. The counter is reset whenever hardware input 2 is on. If input one is from a mechanical displacement flowmeter that delivers 76.54 pulses per gallon, then the highest flow rate is 3.5 gallons per minute. The following equation will deliver one 0.1 second pulse per 100 gallons:

OUT1_EQ contains CTU(IN(1),OUT(1),7654);

Starting at zero, 7653 pulses go by and then pulse 7654 turns on the output. On the next evaluation cycle, the counter is reset because Output 1 is on. This is a result of the order of execution of equations. Output 1 becomes true because the count is reached, but the OUT(1) function has already been evaluated as false. The counter must reset before the next pulse comes in. The output pulse may be extended with a TP function.

TON (power, target) - Whenever power is false, the value of the internal timer is set to zero and the value of the function is false. When power is true then the value of the function will become true after the target amount f time has elapsed. This condition persists as long as power is true. The timer resets when power is false.

The following equation filters the level switch in a stirred tank so that high level bouncing of the float does not create nuisance alarms for the operator. Hardware input 1 senses the level switch and hardware output 1 drives the alarm annunciator with its big horn. The level switch must stay closed for 5 minutes before the alarm is energized and the operator is startled by the horn.

OUT1_EQ contains: TON(IN(1),3000);

TOF (power, target) - Whenever power is true, the value of the internal timer is set to the target and the value of the function is true. The value of the function will become false after the target amount of time has elapsed. This condition persists as long as power is false.

The following equation keeps the outlet valve open for about 5 seconds after the pump is shut off, so that the pressure across the pump can equalize. Hardware output 1 runs the pump and hardware output 2 opens the valve

OUT1_EQ contains: <something that controls the pump>;

OUT2_EQ contains: TOF(OUT(1),50);

TP (power, target) - Whenever power transitions from false to true, the value of the internal timer is set to the target and the value of the function is true. The value of the function will become false after the target amount of time has elapsed. This function is similar to TOF except that a timing cycle is only initiated by the rise of power. Power may go false or stay true without affecting the timing cycle. The cycle is restarted anytime that power goes true after the function has had at least one evaluation cycle as false.

Latching Functions

A latch is a two state device that can be set to true or reset to false. It will retain its state when both commands are false. It will not retain its state through a device restart. The initial state is Reset. Two latch functions are required to define the behavior when both commands are true, depending on which state should be dominant. The result of the function is the state of the latch.

SR (set, reset) - The parameters set and reset are functions. If both are true then set wins and the result of the function is true.

RS (set, reset) - The parameters set and reset are functions. If both are true then reset wins and the result of the function is false.

Shifting Functions

A shift register is a set of bits that moves each bit to the next bit position when the command to shift is given. The vacant bit is filled with the value of the input. The 848L shift functions contain 8 bit registers. The bit parameter selects the bit in the register to test. The value of the function is the value of the tested bit. The shift may be to the left or the right. The following table shows the state of the register for three shifts after the register has been reset. The input is true during the first shift evaluation and false thereafter. The right most bit is bit 1 and the left most bit is bit 8.

Direction	Reset	Shift 1	Shift 2	Shift 3
Left	00000000	00000001	00000010	00000100
Right	00000000	10000000	01000000	00100000

The reset parameter clears the register, overriding both input and shift. Reset is an optional parameter, but the function can be written with three parameters or four. Do not use an extra comma if reset is omitted.

The register data will be cleared on a processor restart (i.e. power cycle).

SHL (input, shift, reset, testbit) - The parameters input, shift, and reset are functions. The parameter testbit is a constant that is constrained to be in the range of 1 to 8. The reset function is optional. If reset is present and true, the 8 bit register is cleared to zero and the result of the function is false. Otherwise, if shift is true then bit 7 will be moved to bit 8, bit 6 to bit 7, bit 5 to bit 6, bit 4 to bit 5, bit 3 to bit 4, bit 2 to bit 3, bit 1 to bit 2, and the value of input will become the value of bit 1. Then the bit specified by testbit will be tested to determine the value of the function.

SHR (input, shift, reset, testbit) - The parameters input, shift and reset are functions. The parameter testbit is a constant that is constrained to be in the range of 1 to 8. The reset function is optional. If reset is present and true, the 8 bit register is cleared to zero and the result of the function is false. Otherwise, if shift is true then bit 2 will be moved to bit 1, bit 3 to bit 2, bit 4 to bit 3, bit 5 to bit 4, bit 6 to bit 5, bit 7 to bit 6, bit 8 to bit 7, and the value of input will become the value of bit 8. Then the bit specified by testbit will be tested to determine the value of the function.

The following procedure is used to enter the logic equations.

1. Set MODE_BLK.TARGET to OOS
2. Enter the equations in parameters EQn where n=1 to 16 or OUT1_EQ, OUT2_EQ, OUT3_EQ or OUT4_EQ. Each equation ending with a semicolon.
3. Set the MODE_BLK.TARGET to AUTO

The equations will then be evaluated and the status of the evaluation shown in the parameter PARSE_RESULT. If any errors were found the block will remain in the OOS mode.

Status Propagation

The contact and Boolean value has a binary value and a good/bad status.

A status is applied to a channel value in one of the following ways:

The hardware input device maybe able to tell if it is shorted or open, in addition to on or off. If the hardware cannot tell then the status is always good, unless a device failure prevents reading the I/O data.

The evaluation of an equation propagates either Good Non-cascade or Bad, both Non-specific.

Each function that is evaluated determines both a value and a status of either good or bad. The functions that provide status are the functions that test a channel number - IN, ICF, ICR, OUT, DO, PS and EQ. If any of the function’s parameters have a Bad or Uncertain status with any sub-status then the function terminates and returns a bad status, otherwise it returns a good value and status.

When an equation (set of functions) is evaluated, if a function returns a bad status then evaluation of that equation stops, and the equation channel status is set to Bad, Non-specific. If evaluation goes to completion, the channel status will be set to Good Process, Non-specific, not limited.

Status propagates forward, in the direction of the last output equation. If a function references an equation that is the equation being evaluated or a later equation, then the status of that equation will be ignored. The function will use the last good value of the referenced equation and call its status Good. This prevents forward references to equations that reference this equation from locking both equations into Bad status if either ever sets Bad status.

During initialization of the logic transducer block, before the first execution, each equation channel status is set to Bad, Non-specific, constant and the value is set to False.

Logic Execution Timing

The Logic transducer block reads the hardware inputs, processes the equations and drives the outputs on a continuous cycle. The cycle time or frequency of execution will vary depending on the number and type of logic functions used in the equations.

DISCRETE INPUT BLOCKS

The DI blocks are used to communicate the current value of a contact, the state of one of the Boolean equations, or the state of an output. The DI block chooses the value through the Channel parameter. Alternatively, the DI block can be configured to pass 8 values in a packed format to the host system (DeltaV) by using channels 7 to 41. To set the channel number use the following procedure for each DI block.

1. Set MODE_BLK.TARGET to OOS
2. Select the Channel parameter
3. Select the desired channel number
4. Set MODE_BLK.TARGET to AUTO

Channel 1= “Input 1”	Channel 24= “EQ 8”
Channel 2= “Input 2”	Channel 25= “EQ 9”
Channel 3= “Input 3”	Channel 26= “EQ 10”
Channel 4= “Input 4”	Channel 27= “EQ 11”
Channel 5= “Input 5”	Channel 28= “EQ 12”
Channel 6= “Input 6”	Channel 29= “EQ 13”
Channel 7= “Input 7”	Channel 30= “EQ 14”
Channel 8= “Input 8”	Channel 31= “EQ 15”
Channel 9= “DO 1”	Channel 32= “EQ 16”
Channel 10= “DO 2”	Channel 33= “Output 1”
Channel 11= “DO 3”	Channel 34= “Output 2”
Channel 12= “DO 4”	Channel 35= “Output 3”
Channel 13= “DO 5”	Channel 36= “Output 4”
Channel 14= “DO 6”	Channel 37= “Packed Inputs”
Channel 15= “DO 7”	Channel 38= “Packed DO”
Channel 16= “DO 8”	Channel 39= “Packed EQ1”
Channel 17= “EQ 1”	Channel 40= “Packed EQ2”
Channel 18= “EQ 2”	Channel 41= “Packed Outputs”
Channel 19= “EQ 3”	Channel 42= “Array Inputs” (MDI Only)
Channel 20= “EQ 4”	Channel 43= “Array DO” (MDI Only)
Channel 21= “EQ 5”	Channel 44= “Array EQ1” (MDI Only)
Channel 22= “EQ 6”	Channel 45= “Array EQ2” (MDI Only)
Channel 23= “EQ 7”	Channel 46= “Array Outputs” (MDI Only)

Simulation

Simulation replaces the channel value coming from the transducer block for testing purposes.

The following procedure is used to simulate a DI output.
To change the output value place the Target Mode of the block to Manual and then change the OUT_D.VALUE to the desired value.

To simulate both the value and status do the following:

1. If the Simulate Switch is in the OFF position, move it to ON. If the Simulate switch is already in the ON position, you must move it to Off an place it back in to the ON position.

NOTE
As a safety measure, the switch must be reset every time power is interrupted to the device in order to enable SIMULATE. This prevents a device that is tested on the bench from getting installed in the process with SIMULATE still active.

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2. To change both the OUT_D.VALUE and OUT_D.STATUS of the DI Block, set the TARGET MODE to AUTO.
3. Set SIMULATE_D.ENABLE_DISABLE to ‘Active’.
4. Enter the desired values for SIMULATE_D. SIMULATE_VALUE and SIMULATE_D. SIMULATE_STATUS.

If errors occur when performing the above steps, be sure that the SIMULATE switch has been reset after powering up the device.

DISCRETE OUTPUT BLOCKS

The digital output blocks are used to receive a value from another device to be used to either drive a contact output or to use in the logic equations. The DO blocks make their values available to the 848L by placing the value in a variable called DO (n) where n=1 to 8. Like the DI block, all eight outputs can be communicated in a packed format by selecting the appropriate channel number. The DO block does not drive the outputs directly but sets the state of the internal variables DO(n). To drive an output from the DO block, the DO(n) variable is placed in one of the output equations.
OUT1_EQ = DO(1);

MULTIPLE DISCRETE INPUT BLOCK

The MDI block allows 8 values with their status in one block with 8 individual outputs. The 8 values are selected by one of the “Array” channel numbers.

MULTIPLE DISCRETE OUTPUT BLOCK

The MDO block allows 8 output values with their status in one block with 8 individual inputs. The 8 values are selected by the “Array Outputs” channel number.

Section 4 Operation and Maintenance

SAFETY MESSAGES

Instructions and procedures in this section may require special precautions to ensure the safety of the personnel performing the operations. Information that potentially raises safety issues is indicated by a warning symbol (⚠). Please refer to the following safety messages before performing an operation preceded by this symbol.

Warnings

⚠WARNING

Failure to follow these installation guidelines could result in death or serious injury.

- Make sure only qualified personnel perform the installation.

Electrical shock could cause death or serious injury.

- If the device or sensors are installed in a high voltage environment and a fault condition or installation error occurs, high voltage may be present on transmitter leads and terminals.
- Use extreme caution when making contact with the leads and terminals.

FOUNDATION FIELDBUS INFORMATION

FOUNDATION fieldbus is an all-digital, serial, two-way, multidrop communication protocol that interconnects devices such as transmitters and valve controllers. It is a local area network (LAN) for instruments that enables basic control and I/O to be moved to the field devices. The Rosemount 848L uses FOUNDATION fieldbus technology developed and supported by Emerson Process Management and the other members of the independent Fieldbus Foundation.

Commissioning (Addressing)

To be able to setup, configure, and have a device communicate with other devices on a segment, a device must be assigned a permanent address. Unless requested otherwise, it is assigned a temporary address when shipped from the factory.

If there are two or more devices on a segment with the same address, the first device to start up will use the assigned address (ex. Address 20). Each of the other devices will be given one of the four available temporary addresses. If a temporary address is not available, the device will be unavailable until a temporary address becomes available.

Use the host system documentation to commission a device and assign a permanent address.

HARDWARE MAINTENANCE

The 848L has no moving parts and requires a minimal amount of scheduled maintenance. If a malfunction is suspected, check for an external cause before performing the diagnostics presented below. The 848L has a green LED which indicates that the device has both DC I/O power and power from the bus. Once powered the green LED will remain illuminated as long as the I/O power is available even if bus power is lost.

The red LED indicates that the Resource block is Out of Service. Any hardware fault detected except open or shorted sensors will place the Resource block in the Out of Service mode.

Sensor Check

⚠ The amber LEDs indicate if the 848L is detecting the sensor as open or closed. To check the input circuit you can connect a working sensor at the transmitter and check it's operation. Consult an Emerson Process Management representative for additional assistance.

⚠ It is possible that the sensor LEDs do not reflect the actual state of a sensor since they are activated by the electronics and not directly by the sensor. Use appropriate electrical test equipment to verify actual sensor states.

Communication/Power Check

If the transmitter does not communicate or provides an erratic output, check for adequate voltage to the transmitter. The transmitter requires between 9.0 and 32.0 VDC at the bus terminals to operate with complete functionality. Check for wire shorts, open circuits, and multiple grounds.

Resetting the Configuration (RESTART)

There are two types of restarts available in the Resource Block. The following section outlines the usage for each of these.

Restart Processor (cycling)

Performing a Restart **Processor** has the same effect as removing power from the device and reapplying power.

Restart with Defaults

Performing a Restart with **Defaults** resets the static parameters for all of the blocks to their initial state. This is commonly used to change the configuration and/or control strategy of the device, including any custom configurations done at the Rosemount factory.

TROUBLESHOOTING

FOUNDATION Fieldbus

Symptom	Possible Cause	Corrective Action
Device does not show up in the live list	Network configuration parameters are incorrect	Set the network parameters of the LAS (host system) according to the FF Communications Profile ST: 8 MRD: 10 DLPDU PhLO: 4 MID: 7 TSC: 4 (1 ms) T1: 1920000 (60 s) T2: 5760000 (180 s) T3: 480000 (15 s)
	Network address is not in polled range	Set first Unpolled Node and Number of UnPolled Nodes so that the device address is within range
	Power to the device is below the 9 VDC minimum	Increase the power to at least 9V
	Noise on the power / communication is too high	Verify terminators and power conditioners are within specification Verify that the shield is properly terminated and not grounded at both ends. It is best to ground the shield at the power conditioner
Device that is acting as a LAS does not send out CD	LAS Scheduler was not downloaded to the Backup LAS device	Ensure that all of the devices that are intended to be a Backup LAS are marked to receive the LAS schedule
All devices go off live list and then return	Live list must be reconstructed by Backup LAS device	Current link setting and configured links settings are different. Set the current link setting equal to the configured settings.

Resource Block

Symptom	Possible Causes	Corrective Action
Mode will not leave OOS	Target mode not set	Set target mode to something other than OOS.
	Memory Failure, Communication Failure, Body Temperature Failure	BLOCK_ERR will show the lost NV Data or Lost Static Data bit set. Restart the device by setting RESTART to Processor. If the block error does not clear, call the factory.
	No I/O Power	Ensure power at I/O Power Terminals are between 9-32 VDC.
Block Alarms Will not work	Features	FEATURE_SEL does not have Alerts enabled. Enable the report bit.
	Notification	LIM_NOTIFY is not high enough. Set equal to MAX_NOTIFY.

I/O Transducer and Logic Block Troubleshooting

Symptom	Possible Causes	Corrective Action
Mode will not leave OOS	Target mode not set	Set target mode to something other than OOS.
	Resource block	The actual mode of the Resource block is in OOS. See Resource Block Diagnostics for corrective action.
	i/O Transducer Block	The actual mode of the Transducer Block is OOS, set it to Auto

NAMUR Sensors

Symptom	Possible Causes	Corrective Action
I/O Failure	Open or shorted sensor	Check sensor and wiring

Appendix A Reference Data

SPECIFICATIONS

Functional Specifications

Inputs

8 Discrete Inputs suitable for NAMUR specification sensors, 9-32VDC sourcing sensors or general switch inputs (dry contact)

NAMUR Sensors:
On state: > 2.1 mA
Off state: < 1.2 mA

9-32 VDC Sourcing Sensors:
On state: > 50% of I/O voltage
Off state: < 20% of I/O voltage

General Switch Inputs:
On state: < 500 Ohms
Off state: > 5k Ohms

Minimum Pulse Width: 1ms
Maximum Pulse Input Frequency: 500Hz

Outputs

4 Discrete Outputs

9-32 VDC loads

Maximum load inductance 300 mH

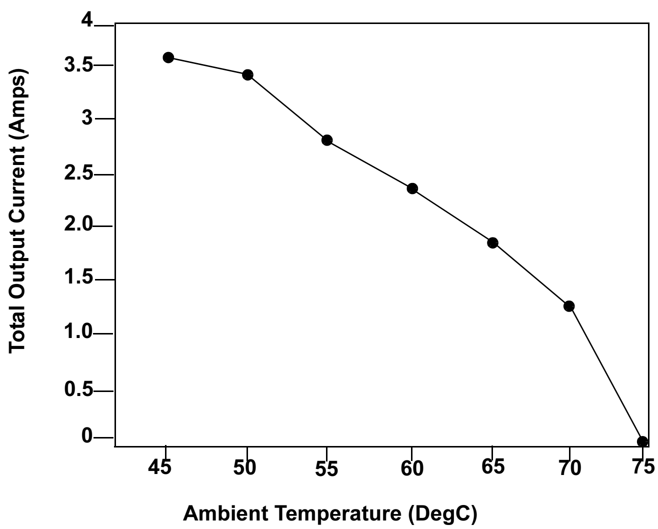
Current Ratings: 1.0 A maximum for single channel on, 4.0 A maximum per device.

Output devices must be selected as follows:

1. Designed to use the same DC voltage as supplied to the 848L I/O power terminals.
2. The DC resistance must be large enough that they consume no more than 1 amp of current steady state. The internal impedance of the 848L is negligible, therefore the Output device's current is simply calculated as: I/O power / DC resistance.
3. The inductance of the output device must be less than 300 mH.

The maximum total output current for the device will depend on the ambient temperature as shown in Figure A-1.

Figure A-1. Temperature vs. Output Current



Thermal Shutdown Protection prevents damage to the device if temperature specifications are exceeded.

Isolation

Input-Output

1200 VDC; 600 V rms 50/60 Hz for dry
and 2-wire NAMUR contact inputs
No isolation when using 3-wire sensors

Input- Foundation Fieldbus

1200 VDC; 600 V rms 50/60 Hz

Output- Foundation Fieldbus

1200 VDC; 600 V rms 50/60 Hz

Input power- Foundation Fieldbus

1200 VDC; 600 V rms 50/60 Hz

Input / Output Power Requirements

24 VDC nominal, 9 VDC minimum, 32 VDC maximum

Supply Current Rating 0.5 amps at 24 VDC plus output load

Fieldbus Segment Power

Powered over the H1 Foundation fieldbus with standard fieldbus power supplies. The logic transmitter operates between 9.0 and 32.0 VDC at 22 milliamps.

Transient Protection (consult factory for availability)

The transient protector (option code T1) helps to prevent damage to the transmitter from transients induced on the bus/power wiring by lightening, welding, heavy electrical equipment, or switch gears. This option is installed at the factory for the Model 848L and is not intended for field installation.

ASME B 16.5 (ANSI)/IEEE C62.41-1991

(IEEE 587), Location Categories A2, B3.

1 kV peak (10 x 1000 S Wave)

6 kV / 3 kA peak (1.2 x 50 S Wave 8 x 20 S Combination Wave)

6 kV / 0.5 kA peak (100 kHz Ring Wave)

4 kV peak EFT (5 x 50 nS Electrical Fast Transient)

Physical Specifications

Environmental Ratings

Electronics (no enclosure)
-40°C to +85°C
99% non-condensing humidity
IP20

Unit (electronics and enclosure)
-40°C to +85°C
100% condensing humidity
IP66

Function Blocks Specification

H1 Segment Device

Back-up LAS

Resource Block

I/O Transducer Block
All inputs can optionally be latched for the duration necessary for each input to be read during a macrocycle

Logic Transducer Block (20 Boolean Equations)
The processing cycle of the 848L logic equations from sampling the inputs to driving the outputs will vary depending upon the number and type of functions used in the 20 equations. Processing time can vary in the range of 50 to 150ms.

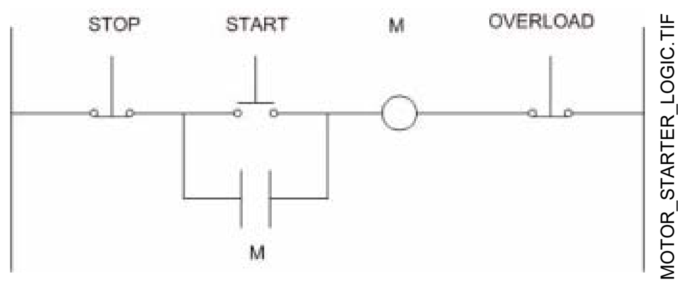
Logic Functions
AND, OR, XOR, NOT
Rising Edge Trigger
Falling Edge Trigger
Turn On Delay
Turn Off Delay
Pulse Counter
Reset
Set Latch
Shift Register Right
Shift Register Left

Function Blocks
8 DI blocks, 4 DO blocks, 1 MDI block,
and 1 MDO block are provided.

Foundation Fieldbus:

- Links 25
- VCR 20

EXAMPLE FOR THE LOGIC EXECUTION:
This diagram shows motor starter logic with start and stop buttons and an auxiliary contact which maintains current after the start button is pressed.



Which would translate to a Boolean equation of:

AND(IN(1),OR(IN(2),IN(3)))

DIMENSIONAL DRAWINGS

Figure A-2. Rosemount 848L Dimensional Drawings

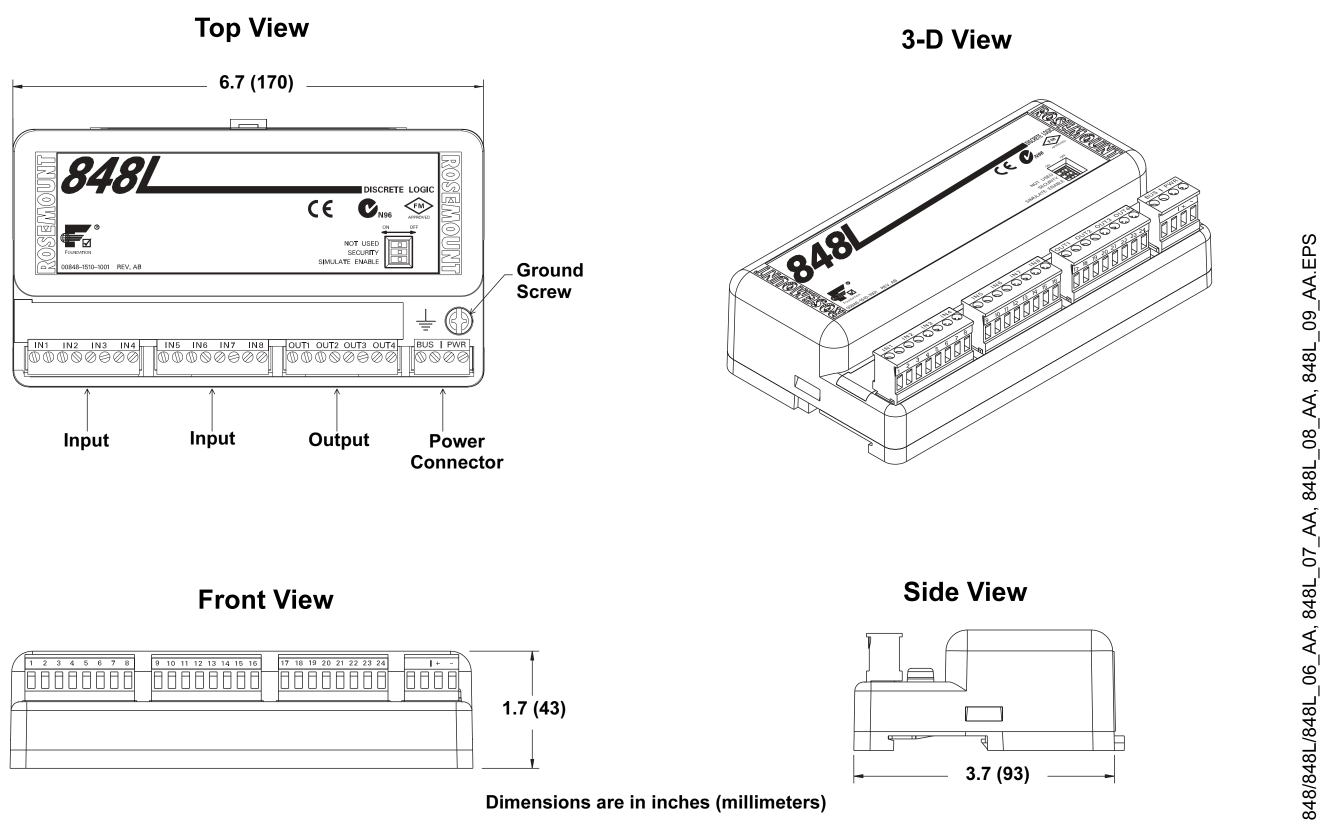
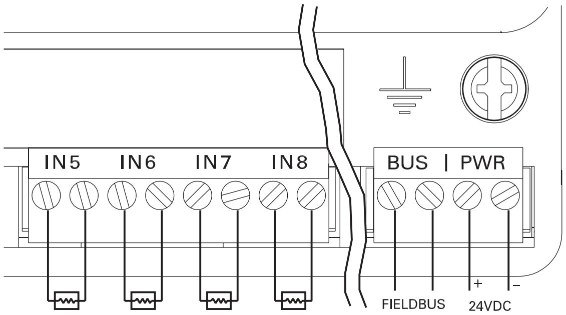
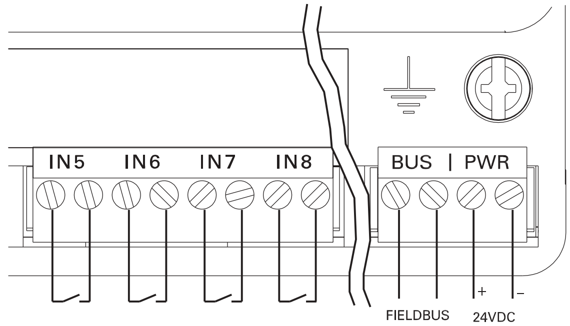


Figure A-3. Rosemount 848L Wiring Diagram

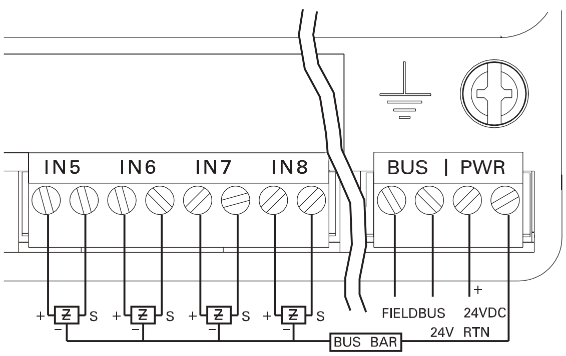
DISCRETE INPUT WIRING CONFIGURATION



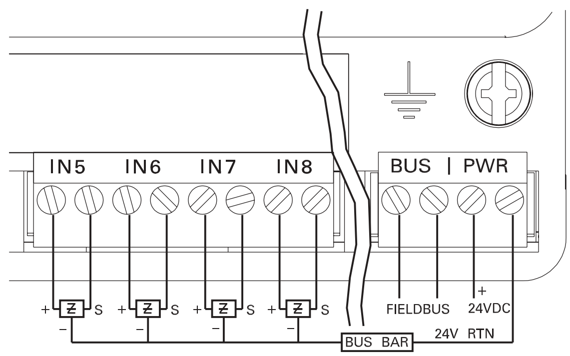
2-Wire NAMUR Sensors
1 of 2 Input Connectors



Dry Contact Switches
1 of 2 Input Connectors

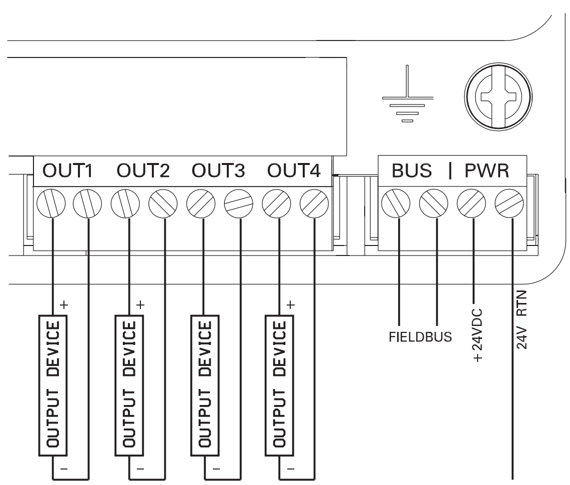


3-Wire NAMUR Sensors
1 of 2 Input Connectors



9-32 VDC Sensors
1 of 2 Input Connectors

DISCRETE OUTPUT WIRING CONFIGURATION



9-32 VDC Outputs

848/848L/848L_10_AA, 848L_11_AA, 848L_12_AA, 848L_13_AA, 848L_14_AA.EPS

ORDERING INFORMATION

Model	Product Description (Includes One Fieldbus H1 Segment)	
848L	Fieldbus Logic Transmitter	
Code	**Communications Protocol**	
F	FOUNDATION™ fieldbus digital signal (includes 8 DI, 4 DO, 1 MDI, and 1 MDO function blocks, and Backup Link Active Scheduler)	
Code	**Power Input**	
A	Bus and I/O Power (4-wire)	
Code	**Product Certifications**	**Rosemount Junction Box required?**
NA	No Approval	No
N1	CENELEC ATEX Type n (enclosure required)	Yes
NC	CENELEC ATEX Type n Component	No(1)
ND	CENELEC ATEX Dust Ignition Proof	Yes
N5	FM Non-Incendive for Class 1, Division 2, Groups A, B, C, D	Yes
N6	CSA Non-Incendive for Class 1, Division 2, Groups A, B, C, D	Yes
N7	IECEx Type n Approval (consult factory for availability) (enclosure required)	
Code	**Discrete Inputs and Outputs Types**	
S001	8 - Dry Contact Inputs / 4 - 9 to 32 VDC Outputs	
S002	8 - 2-wire NAMUR Sensor Inputs / 4 - 9 to 32 VDC Outputs	
S003	8 - 3-wire NAMUR Sensor Inputs / 4 - 9 to 32 VDC Outputs	
S004	8 - 9 to 32 VDC Inputs / 4 - 9 to 32 VDC Outputs	
Code	**Options**	
	Transient Protection	
T1	Transient Protection (Consult factory for availability)	
	Mounting Kit Options	
B6	Mounting Kit to a 2 in. pipe	
	Non Explosion-Proof Junction Box Options	
JP1	Plastic Junction Box; No Entries	
JP2	Plastic Junction Box; Cable Glands (9 X M20 nickel-plated brass glands for 7.5-11.9 mm unarmored cable)	
JP3	Plastic Junction Box; Conduit Entries (5 Plugged Holes, suitable for installing $^1/_2$-in. NPT fittings)	
JA1	Aluminum Junction Box; No Entries	
JA2	Aluminum Cable Glands (9 X M20 nickel-plated brass glands for 7.5-11.9 mm unarmored cable)	
JA3	Aluminum Conduit Entries (5 Plugged Holes, suitable for installing $^1/_2$-in. NPT fittings)	
JS1	Stainless Steel Junction Box; No Entries	
JS2	SST Box; Cable Glands (9 X M20 nickel-plated brass glands for 7.5-11.9 mm unarmored cable)	
JS3	Stainless Steel Box, Conduit Entries (5 Plugged Holes, suitable for installing $^1/_2$-in. NPT fittings)	
	Conduit Electrical Connector	
GE(2)	M12, 4-pin, Male Connector (*eurofast®*)	
GM(2)	A size Mini, 4-pin, Male Connector (*minifast®*)	
	Software Options	
CT	Disable Local Logic Function	
Typical Model Number:	**848L F A NA S001 T1 JP1**	

(1) *The Rosemount 848L ordered with option code NC is not approved as a stand-alone unit. Additional system certification is required.*

(2) *Not available with certain hazardous location certifications. Contact a Rosemount representative for details.*

Appendix B Product Certifications

APPROVED MANUFACTURING LOCATIONS

Rosemount Inc. — Chanhassen, Minnesota USA

Emerson Process Management Asia Pacific
Private Limited — Singapore

Rosemount Temperature GmbH - Karlstein, Germany

EUROPEAN DIRECTIVE INFORMATION

The EC declaration of conformity for all applicable European directives for this product can be found on the Rosemount website at www.rosemount.com. A hard copy may be obtained by contacting our local sales office.

HAZARDOUS LOCATIONS CERTIFICATES

North American Approvals

Factory Mutual (FM) Approvals

N5 Nonincendive for Class I, Division 2, Groups A, B, C, D
when installed per Rosemount drawing 00848-1035.
Temperature code: T4 (T_{amb} = –40°C to 60°C)

Canadian Standards Association (CSA) Approvals

N6 Suitable for Class I, Division 2, Groups A, B, C, D
when installed per Rosemount drawing 00848-1036.
Temperature code: T4 (T_{amb} = –40°C to 60°C)

European Approvals

CENELEC Approvals

N1 CENELEC Type n
Certification Number: Baseefa04ATEX0027X
ATEX Marking Ⓔx II 3 G
EEx nA nL IIC T4 (T_{amb} = –40°C to 50°C)
Power/Bus
Max Supply Voltage = 32.0 V
CE

Special Conditions for Safe Use (x):

1. The ambient temperature range of use shall be the most restrictive of the apparatus, cable gland or blanking plug.
2. The apparatus is not capable of withstanding the 500V insulation test required by Clause 9.4 of EN 50021:1999 or Clause 8.1 of EN 60079:2003. This must be taken into account when installing the apparatus.
3. Component approved EEx e cable entries must be used so as to maintain the ingress protection of the enclosure to at least IP54.
4. Any unused cable entry holes must be filled with component approved EEx e blanking plugs.

NC CENELEC Type n Component
Certification Number: Baseefa04ATEX0026U
ATEX Marking Ⓔx II 3 G
EEx nA nL IIC T4 (T_{amb} = -40°C to 50°C)
CE

Special Conditions for Safe Use (x):

1. The component must be installed in a suitable certified enclosure capable of withstanding an impact of 7.0J.
2. The apparatus is not capable of withstanding the 500V insulation test required by Clause 9.4 of EN 50021:1999 or Clause 8.1 of EN 60079:2003. This must be taken into account when installing the apparatus.

ND CENELEC Dust Ignition Proof
Certification Number: Baseefa04ATEX0028X
ATEX Marking Ⓔx II 1 D
T90°C (T_{amb} = – 20°C to 65°C)
CE 1180

Special Conditions for Safe Use (x):

1. Component approved EEx e cable entries must be used so as to maintain the ingress protection of the enclosure to at least IP66.
2. Any unused cable entry hole must be filled with component approved EEx e blanking plugs.
3. The ambient temperature range of use shall be the most restrictive of the apparatus, cable gland or blanking plug.

Appendix C Function Blocks

RESOURCE BLOCK PARAMETERS

Table C-1. Resource Block Parameters

Number	Parameter	Description
1	ST_ REV	The revision level of the static data associated with the function block.
2	TAG_ DESC	The user description of the intended application of the block.
3	STRATEGY	The strategy field can be used to identify grouping of blocks.
4	ALERT_ KEY	The identification number of the plant unit.
5	MODE_ BLK	The actual, target, permitted, and normal modes of the block. For further description, see the Mode parameter formal model in FF-890.
6	BLOCK_ ERR	This parameter reflects the error status associated with the hardware or software components associated with a block. Multiple errors may be shown. For a list of enumeration values, see FF-890, Block_ Err formal model.
7	RS_ STATE	State of the function block application state machine. For a list of enumeration values, see FF-890.
8	TEST_ RW	Read/write test parameter - used only for conformance testing.
9	DD_ RESOURCE	String identifying the tag of the resource which contains the Device Description for the resource.
10	MANUFAC_ ID	Manufacturer identification number - used by an interface device to locate the DD file for the resource.
11	DEV_ TYPE	Manufacturer's model number associated with the resource - used by interface devices to locate the DD file for the resource.
12	DEV_ REV	Manufacturer revision number associated with the resource - used by an interface device to locate the DD file for the resource.
13	DD_ REV	Revision of the DD associated with the resource - used by the interface device to locate the DD file for the resource.
14	GRANT_ DENY	Options for controlling access of host computer and local control panels to operating, tuning and alarm parameters of the block.
15	HARD_ TYPES	The types of hardware available as channel numbers. The supported hardware type is: SCALAR_ INPUT
16	RESTART	Allows a manual restart to be initiated.
17	FEATURES	Used to show supported resource block options. The supported features are: SOFT_ WRITE_ LOCK_ SUPPORT, HARD_ WRITE_ LOCK_ SUPPORT, REPORTS, and UNICODE
18	FEATURE_ SEL	Used to select resource block options.
19	CYCLE_ TYPE	Identifies the block execution methods available for this resource. The supported cycle types are: SCHEDULED, and COMPLETION_ OF_ BLOCK_ EXECUTION
20	CYCLE_ SEL	Used to select the block execution method for this resource.
21	MIN_ CYCLE_T	Time duration of the shortest cycle interval of which the resource is capable.
22	MEMORY_ SIZE	Available configuration memory in the empty resource. To be checked before attempting a download.

Table C-1. Resource Block Parameters

Number	Parameter	Description
23	NV_ CYCLE_T	Minimum time interval specified by the manufacturer for writing copies of NV parameters to non-volatile memory. Zero means it will never be automatically copied. At the end of NV_ CYCLE_T, only those parameters which have changed need to be updated in NVRAM.
24	FREE_ SPACE	Percent of memory available for further configuration. Zero in preconfigured resource.
25	FREE_ TIME	Percent of the block processing time that is free to process additional blocks.
26	SHED_ RCAS	Time duration at which to give up on computer writes to function block RCas locations. Shed from RCas will never happen when SHED_ RCAS = 0.
27	SHED_ ROUT	Time duration at which to give up on computer writes to function block ROut locations. Shed from ROut will never happen when SHED_ ROUT = 0.
28	FAULT_ STATE	Condition set by loss of communication to an output block, fault promoted to an output block or physical contact. When FAULT_ STATE condition is set, then output function blocks will perform their FAULT_ STATE actions.
29	SET_ FSTATE	Allows the FAULT_ STATE condition to be manually initiated by selecting Set.
30	CLR_ FSTATE	Writing a Clear to this parameter will clear the device FAULT_ STATE if the field condition has cleared.
31	MAX_ NOTIFY	Maximum number of unconfirmed notify messages possible.
32	LIM_ NOTIFY	Maximum number of unconfirmed alert notify messages allowed.
33	CONFIRM_ TIME	The time the resource will wait for confirmation of receipt of a report before trying again. Retry will not happen when CONFIRM_ TIME = 0.
34	WRITE_ LOCK	If set, no writes from anywhere are allowed, except to clear WRITE_ LOCK. Block inputs will continue to be updated.
35	UPDATE_ EVT	This alert is generated by any change to the static data.
36	BLOCK_ ALM	The BLOCK_ ALM is used for all configuration, hardware, connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status attribute. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.
37	ALARM_ SUM	The current alert status, unacknowledged states, unreported states, and disabled states of the alarms associated with the function block.
38	ACK_ OPTION	Selection of whether alarms associated with the block will be automatically acknowledged.
39	WRITE_ PRI	Priority of the alarm generated by clearing the write lock.
40	WRITE_ ALM	This alert is generated if the write lock parameter is cleared.
41	ITK_ VER	Major revision number of the interoperability test case used in certifying this device as interoperable. The format and range are controlled by the Fieldbus Foundation.
42	DISTRIBUTOR	Reserved for use as distributor ID. No Foundation enumerations defined at this time.
43	DEV_STRING	This is used to load new licensing into the device. The value can be written but will always read back with a value of 0.
44	XD_ OPTIONS	Indicates which transducer block licensing options are enabled.
45	FB_ OPTIONS	Indicates which function block licensing options are enabled.
46	DIAG_ OPTIONS	Indicates which diagnostics licensing options are enabled.
47	MISC_ OPTIONS	Indicates which miscellaneous licensing options are enabled.
48	RB_ SFTWR_ REV_ MAJOR	Major revision of software that the resource block was created with.
49	RB_ SFTWR_ REV_ MINOR	Minor revision of software that the resource block was created with.
50	RB_ SFTWR_ REV_ BUILD	Build of software that the resource block was created with.
51	RB_SFTWR_REV_ ALL	The string contains the following fields: Major rev: 1-3 characters, decimal number 0-255 Minor rev: 1-3 characters, decimal number 0-255 Build rev: 1-3 characters, decimal number 0-255 Time of build: 8 characters, xx:xx:xx, military time Day of week of build: 3 characters, Sun, Mon, Month of build: 3 characters, Jan, Feb. Day of month of build: 1-2 characters, decimal number 1-31 Year of build: 4 characters, decimal Builder: 7 characters, login name of builder
52	HARDWARE_ REV	Hardware revision of that hardware that has the resource block in it.

Table C-1. Resource Block Parameters

Number	Parameter	Description
53	OUTPUT_ BOARD_ SN	Output board serial number.
54	FINAL_ ASSY_ NUM	The same final assembly number specified or set by the customer.
55	DETAILED_ STATUS	Indicates the state of the transmitter.
56	SUMMARY_ STATUS	An enumerated value of repair analysis.
57	MESSAGE_ DATE	Date associated with the MESSAGE_ TEXT parameter
58	MESSAGE_ TEXT	Used to indicate changes made by the user to the device installation, configuration, or calibration.
59	SELF_ TEST	Used to self test the device. Tests are device specific.
60	DEFINE_ WRITE_ LOCK	Allows the operator to select how WRITE_ LOCK behaves. The initial value is "lock everything". If the value is set to "lock only physical device" then the resource and transducer blocks of the device will be locked but changes to function blocks will be allowed.
61	SAVE_ CONFIG_ NOW	Allows the user to optionally save all non-volatile information immediately.
62	SAVE_ CONFIG_ BLOCKS	Number of EEPROM blocks that have been modified since last burn. This value will count down to zero when the configuration is saved.
63	START_ WITH_ DEFAULTS	0 = Uninitialized 1 = do not power-up with NV defaults 2 = power-up with default node address 3 = power-up with default pd_ tag and node address 4 = power-up with default data for the entire communications stack (no application data)
64	SIMULATE_ IO	Status of Simulate jumper/switch
65	SECURITY_ IO	Status of Security jumper/switch
66	SIMULATE_ STATE	The state of the simulate jumper 0 = Uninitialized 1 = Jumper/switch off, simulation not allowed 2 = Jumper/switch on, simulation not allowed (need to cycle jumper/switch) 3 = Jumper/switch on, simulation allowed
67	DOWNLOAD_ MODE	Gives access to the boot block code for over the wire downloads 0 = Uninitialized 1 = Run Mode 2 = Download Mode
68	RECOMMENDED_ ACTION	Enumerated list of recommended actions displayed with a device alert.
69	FAILED_ PRI	Designates the alarming priority of the FAILED_ ALM.
70	FAILED_ ENABLE	Enabled FAILED_ ALM alarm conditions. Corresponds bit for bit to the FAILED_ ACTIVE. A bit on means that the corresponding alarm condition is enabled and will be detected. A bit off means the corresponding alarm condition is disabled and will not be detected.
71	FAILED_ MASK	Mask of FAILED_ ALM. Corresponds bit for bit to FAILED_ ACTIVE. A bit on means that the condition is masked out from alarming.
72	FAILED_ ACTIVE	Enumerated list of failure conditions within a device.
73	FAILED_ ALM	Alarm indicating a failure within a device which makes the device non-operational.
74	MAINT_ PRI	Designates the alarming priority of the MAINT_ ALM
75	MAINT_ ENABLE	Enabled MAINT_ ALM alarm conditions. Corresponds bit for bit to the MAINT_ ACTIVE. A bit on means that the corresponding alarm condition is enabled and will be detected. A bit off means the corresponding alarm condition is disabled and will not be detected.
76	MAINT_ MASK	Mask of MAINT_ ALM. Corresponds bit for bit to MAINT_ ACTIVE. A bit on means that the condition is masked out from alarming.
77	MAINT_ ACTIVE	Enumerated list of maintenance conditions within a device.
78	MAINT_ ALM	Alarm indicating the device needs maintenance soon. If the condition is ignored, the device will eventually fail.
79	ADVISE_ PRI	Designates the alarming priority of the ADVISE_ ALM

Table C-1. Resource Block Parameters

Number	Parameter	Description
80	ADVISE_ ENABLE	Enabled ADVISE_ ALM alarm conditions. Corresponds bit for bit to ADVISE_ ACTIVE. A bit on means that the corresponding alarm condition is enabled and will be detected. A bit off means the corresponding alarm condition is disabled and will not be detected.
81	ADVISE_ MASK	Mask of ADVISE_ ALM. Corresponds bit for bit to ADVISE_ ACTIVE. A bit on means that the condition is masked out from alarming.
82	ADVISE_ ACTIVE	Enumerated list of advisory conditions within a device.
83	HEALTH_ INDEX	Alarm indicating advisory alarms. These conditions do not have a direct impact on the process or device integrity.
84	PWA_ SIMULATE	Parameter representing the overall health of the device, 100 being perfect and 1 being non-functioning. The value will be set based on the active PWA alarms in accordance with the requirements stated in "Device Alerts and Health Index PlantWeb Implementation Rules". Each device may implement its own unique mapping between the PWA parameters and HEALTH_ INDEX although a default mapping will be available based on the following rules. HEALTH_ INDEX will be set based on the highest priority PWA *_ ACTIVE bit as follows: FAILED_ ACTIVE: 0 to 31 - HEALTH_ INDEX = 10 MAINT_ ACTIVE: 27 to 31 - HEALTH_ INDEX = 20 MAINT_ ACTIVE: 22 to 26 - HEALTH_ INDEX = 30 MAINT_ ACTIVE: 16 to 21 - HEALTH_ INDEX = 40 MAINT_ ACTIVE: 10 to 15 - HEALTH_ INDEX = 50 MAINT_ ACTIVE: 5 to 9 - HEALTH_ INDEX = 60 MAINT_ ACTIVE: 0 to 4 - HEALTH_ INDEX = 70 ADVISE_ ACTIVE: 16 to 31 - HEALTH_ INDEX = 80 ADVISE_ ACTIVE: 0 to 15 - HEALTH_ INDEX = 90 NONE - HEALTH_ INDEX = 100
85	ADVISE_ ACTIVE	Allows direct writes to the PlantWeb Alert "ACTIVE" parameters and RB.DETAILED_STATUS. The simulate switch must be "ON' and the SIMULATE_STATE must be "Switch on, simulation allowed" before PWA_SIMULATE can be active.

I/O TRANSDUCER PARAMETERS

Table C-2. I/O Transducer Parameters

Number	Parameter	Description
1	ST_ REV	The revision level of the static data associated with the function block.
2	TAG_ DESC	The user description of the intended application of the block.
3	STRATEGY	The strategy field can be used to identify grouping of blocks.
4	ALERT_ KEY	The identification number of the plant unit.
5	MODE_ BLK	The actual, target, permitted, and normal modes of the block. For further description, see the Mode parameter formal model in FF-890.
6	BLOCK_ ERR	This parameter reflects the error status associated with the hardware or software components associated with a block. Multiple errors may be shown. For a list of enumeration values, see FF-890, Block_ Err formal model.
7	UPDATE_ EVT	This alert is generated by any change to the static data.
8	BLOCK_ ALM	The block alarm is used for all configuration, hardware, connection failure, or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status attribute. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.
9	TRANSDUCER_ DIRECTORY	A directory that specifies the number and starting indices of the transducers in the transducer block. For further information, please refer to the Transducer Block Application Process - Part 1 (FF-902) specification.
10	TRANSDUCER_ TYPE	Identifies the transducer that follows.
11	XD_ ERROR	One of the error codes defined in FF-903 XD_ ERROR and Block Alarm Subcodes.
12	COLLECTION_ DIRECTORY	A directory that specifies the number, starting indices, and DD item IDs of the data collections in each transducer within a transducer block. For further information, please refer FF-902.
13	IN_ 1_ TAG	An identifier associated with discrete input 1.
14	IN1	The value and status of discrete input 1.
15	PULSE_ COUNT_ 1	The number of pulses that have occurred on IN1 since last reset.
16	IN_ 1_ CONFIG.IO_TYPE	The transducer type of discrete sensor 1.
16	IN_ 1_ CONFIG.FILTER	Any state change on IN1 that lasts for a duration less than this filter value, will be ignored by the device.
16	IN_ 1_ CONFIG.FAIL_ SAFE	When the device detects a failure, IO1 will have its value set to this value.
17	IN_ 2_ TAG	An identifier associated with discrete input 2.
18	IN2	The value and status of discrete input 2.
19	PULSE_ COUNT_ 2	The number of pulses that have occurred on IN2 since last reset.
20	IN_ 2_ CONFIG.IO_TYPE	The transducer type of discrete sensor 2.
20	IN_ 2_ CONFIG.FILTER	Any state change on IN2 that lasts for a duration less than this filter value, will be ignored by the device.
20	IN_ 2_ CONFIG.FAIL_ SAFE	When the device detects a failure, IO2 will have its value set to this value.
21	IN_ 3_ TAG	An identifier associated with discrete input 3.
22	IN3	The value and status of discrete input 3.
23	PULSE_ COUNT_ 3	The number of pulses that have occurred on IN3 since last reset.
24	IN_ 3_ CONFIG.IO_TYPE	The transducer type of discrete sensor 3.
24	IN_ 3_ CONFIG.FILTER	Any state change on IN3 that lasts for a duration less than this filter value, will be ignored by the device.
24	IN_ 3_ CONFIG.FAIL_ SAFE	When the device detects a failure, IO3 will have its value set to this value.
25	IN_ 4_ TAG	An identifier associated with discrete input 4.
26	IN4	The value and status of discrete input 4.
27	PULSE_ COUNT_ 4	The number of pulses that have occurred on IN4 since last reset.
28	IN_ 4_ CONFIG.IO_TYPE	The transducer type of discrete sensor 4.
28	IN_ 4_ CONFIG.FILTER	Any state change on IN4 that lasts for a duration less than this filter value, will be ignored by the device.
28	IN_ 4_ CONFIG.FAIL_ SAFE	When the device detects a failure, IO4 will have its value set to this value.

Table C-2. I/O Transducer Parameters

Number	Parameter	Description
29	TRANSDUCER_ TYPE_ 2	Identifies the transducer that follows.
30	XD_ ERROR_ 2	One of the error codes defined in FF-903 XD_ ERROR and Block Alarm Subcodes.
31	COLLECTION_ DIRECTORY_ 2	A directory that specifies the number, starting indices, and DD item IDs of the data collections in each transducer within a transducer block. For further information, please refer FF-902.
32	IN_ 5_ TAG	An identifier associated with discrete input 5.
33	IN5	The value and status of discrete input 5.
34	PULSE_ COUNT_ 5	The number of pulses that have occurred on IN5 since last reset.
35	IN_ 5_ CONFIG.IO_TYPE	The transducer type of discrete sensor 5.
35	IN_ 5_ CONFIG.FILTER	Any state change on IN5 that lasts for a duration less than this filter value, will be ignored by the device.
35	IN_ 5_ CONFIG.FAIL_ SAFE	When the device detects a failure, IO5 will have its value set to this value.
36	IN_ 6_ TAG	An identifier associated with discrete input 6.
37	IN6	The value and status of discrete input 6.
38	PULSE_ COUNT_ 6	The number of pulses that have occurred on IN6 since last reset.
39	IN_ 6_ CONFIG.IO_TYPE	The transducer type of discrete sensor 6.
39	IN_ 6_ CONFIG.FILTER	Any state change on IN6 that lasts for a duration less than this filter value, will be ignored by the device.
39	IN_ 6_ CONFIG.FAIL_ SAFE	When the device detects a failure, IO6 will have its value set to this value.
40	IN_ 7_ TAG	An identifier associated with discrete input 7.
41	IN7	The value and status of discrete input 7.
42	PULSE_ COUNT_ 7	The number of pulses that have occurred on IN7 since last reset.
43	IN_ 7_ CONFIG.IO_TYPE	The transducer type of discrete sensor 7.
43	IN_ 7_ CONFIG.FILTER	Any state change on IN7 that lasts for a duration less than this filter value, will be ignored by the device.
43	IN_ 7_ CONFIG.FAIL_ SAFE	When the device detects a failure, IO7 will have its value set to this value.
44	IN_ 8_ TAG	An identifier associated with discrete input 8.
45	IN8	The value and status of discrete input 8.
46	PULSE_ COUNT_ 8	The number of pulses that have occurred on IN8 since last reset.
47	IN_ 8_ CONFIG.IO_TYPE	The transducer type of discrete sensor 8.
47	IN_ 8_ CONFIG.FILTER	Any state change on IN8 that lasts for a duration less than this filter value, will be ignored by the device.
47	IN_ 8_ CONFIG.FAIL_ SAFE	When the device detects a failure, IO8 will have its value set to this value.
48	TRANSDUCER_ TYPE_ 3	Identifies the transducer that follows.
49	XD_ ERROR_ 3	One of the error codes defined in FF-903 XD_ ERROR and Block Alarm Subcodes.
50	COLLECTION_ DIRECTORY_ 3	A directory that specifies the number, starting indices, and DD item IDs of the data collections in each transducer within a transducer block. For further information, please refer FF-902.
51	OUT_ 1_ TAG	An identifier associated with discrete output 1.
52	OUT1	The value and status of discrete Output 1.
53	OUT_ 1_ CONFIG.IO_TYPE	The transducer type of discrete sensor 9.
53	OUT_ 1_ CONFIG.FILTER	Any state change that lasts for a duration less than this filter value, will be ignored by the device.
53	OUT_ 1_ CONFIG.FAIL_ SAFE	When the device detects a failure, OUT1 will be set to this value.
54	OUT_ 2_ TAG	An identifier associated with discrete output 2.
55	OUT2	The value and status of discrete Output 2.
56	OUT_2_CONFIG.IO_TYPE	The transducer type of discrete sensor 10.
56	OUT_ 2_ CONFIG.FILTER	Any state change that lasts for a duration less than this filter value, will be ignored by the device.
56	OUT_2_CONFIG.FAIL_ SAFE	When the device detects a failure, OUT2 will be set to this value.

Table C-2. I/O Transducer Parameters

Number	Parameter	Description
57	OUT_ 3_ TAG	An identifier associated with discrete output 3.
58	OUT3	The value and status of discrete Output 3.
59	OUT_ 3_ CONFIG.IO_TYPE	The transducer type of discrete sensor 11.
59	OUT_3_CONFIG.FILTER	Any state change that lasts for a duration less than this filter value, will be ignored by the device.
59	OUT_3_CONFIG.FAIL_SAFE	When the device detects a failure, OUT3 will be set to this value.
60	OUT_ 4_TAG	An identifier associated with discrete output 4.
61	OUT4	The value and status of discrete Output 4.
62	OUT_ 4_ CONFIG.IO_TYPE	The transducer type of discrete sensor 12.
62	OUT_ 4_ CONFIG.FILTER	Any state change that lasts for a duration less than this filter value, will be ignored by the device.
62	OUT_ 4_ CONFIG.FAIL_ SAFE	When the device detects a failure, OUT4 will be set to this value.
63	BODY_ TEMP	The value and status of electronics temperature.
64	IO_ SOFT_ REV	The string contains the following fields: Major rev: 1-3 characters, decimal number 0-255 Minor rev: 1-3 characters, decimal number 0-255Build rev: 1-3 characters, decimal number 0-255 Time of build: 8 characters, xx:xx:xx, military time Day of week of build: 3 characters, Sun, Mon, Month of build: 3 characters, Jan, Feb. Day of month of build: 1-2 characters, decimal number 1-31 Year of build: 4 characters, decimal Builder: 7 characters, login name of builder
65	CLEAR_COUNTS	Each bit can be written to in order to reset PULSE_ COUNT_ X. The bits numbered from 1 (LSB) to 8(MSB) will reset PULSE_ COUNT_ 1 to PULSE_ COUNT_ 8 respectively.
66	DETAILED_ STATUS	Indicates the state of the transmitter.
67	MACRO_ IN_ LATCH	Allows transitions of transducer block channels to be held in a specified state until the macrocycle reads the value at least once.
68	MACRO_ EQ_ LATCH	Allows transitions of transducer block channels to be held in a specified state until the macrocycle reads the value at least once.
69	MACRO_ OUT_ LATCH	Allows transitions of transducer block channels to be held in a specified state until the macrocycle reads the value at least once.

LOGIC TRANSDUCER PARAMETERS

Table C-3. Logic Transducer Parameters and Descriptions

Number	Parameter	Description
1	ST_ REV	The revision level of the static data associated with the function block.
2	TAG_ DESC	The user description of the intended application of the block.
3	STRATEGY	The strategy field can be used to identify grouping of blocks.
4	ALERT_ KEY	The identification number of the plant unit.
5	MODE_ BLK	The actual, target, permitted, and normal modes of the block. For further description, see the Mode parameter formal model in FF-890.
6	BLOCK_ ERR	This parameter reflects the error status associated with the hardware or software components associated with a block. Multiple errors may be shown. For a list of enumeration values, see FF-890, Block_ Err formal model.
7	UPDATE_ EVT	This alert is generated by any change to the static data.
8	BLOCK_ ALM	The block alarm is used for all configuration, hardware, connection failure, or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status attribute. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.
9	TRANSDUCER_ DIRECTORY	A directory that specifies the number and starting indices of the transducers in the transducer block. For further information, please refer to the Transducer Block Application Process - Part 1 (FF-902) specification.
10	TRANSDUCER_ TYPE	Identifies the transducer that follows.
11	XD_ ERROR	One of the error codes defined in FF-903 XD_ ERROR and Block Alarm Subcodes.
12	COLLECTION_ DIRECTORY	A directory that specifies the number, starting indices, and DD item IDs of the data collections in each transducer within a transducer block. For further information, please refer FF-902.
13	EQ1	A boolean equation used to define the computation of EQ1_ VALUE.
14	EQ2	A boolean equation used to define the computation of EQ2_ VALUE.
15	EQ3	A boolean equation used to define the computation of EQ3_ VALUE.
16	EQ4	A boolean equation used to define the computation of EQ4_ VALUE.
17	EQ5	A boolean equation used to define the computation of EQ5_ VALUE.
18	EQ6	A boolean equation used to define the computation of EQ6_ VALUE.
19	EQ7	A boolean equation used to define the computation of EQ7_ VALUE.
20	EQ8	A boolean equation used to define the computation of EQ8_ VALUE.
21	EQ9	A boolean equation used to define the computation of EQ9_ VALUE.
22	EQ10	A boolean equation used to define the computation of EQ10_ VALUE.
23	EQ11	A boolean equation used to define the computation of EQ11_ VALUE.
24	EQ12	A boolean equation used to define the computation of EQ12_ VALUE.
25	EQ13	A boolean equation used to define the computation of EQ13_ VALUE.
26	EQ14	A boolean equation used to define the computation of EQ14_ VALUE.
27	EQ15	A boolean equation used to define the computation of EQ15_ VALUE.
28	EQ16	A boolean equation used to define the computation of EQ16_ VALUE.
29	OUT1_ EQ	A boolean equation used to define the computation of OUT1_ VALUE.
30	OUT2_ EQ	A boolean equation used to define the computation of OUT2_ VALUE.
31	OUT3_ EQ	A boolean equation used to define the computation of OUT3_ VALUE.
32	OUT4_ EQ	A boolean equation used to define the computation of OUT4_ VALUE.
33	PARSE_ RESULT	A feedback string that displays the result of parsing EQ1 - EQ16, and OUT1_ EQ - OUT4_ EQ.
34	EQ1_ VALUE	The value and status of the result of computing EQ1.
35	EQ2_ VALUE	The value and status of the result of computing EQ2.
36	EQ3_ VALUE	The value and status of the result of computing EQ3.
37	EQ4_ VALUE	The value and status of the result of computing EQ4.
38	EQ5_ VALUE	The value and status of the result of computing EQ5.
39	EQ6_ VALUE	The value and status of the result of computing EQ6.
40	EQ7_ VALUE	The value and status of the result of computing EQ7.
41	EQ8_ VALUE	The value and status of the result of computing EQ8.
42	EQ9_ VALUE	The value and status of the result of computing EQ9.

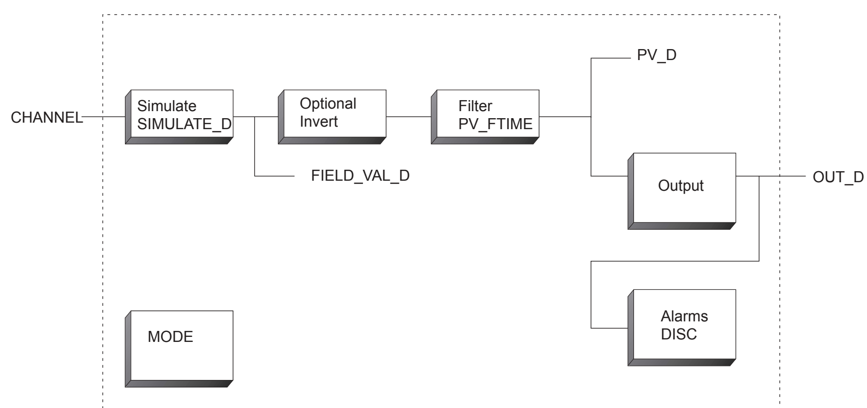
Table C-3. Logic Transducer Parameters and Descriptions

Number	Parameter	Description
43	EQ10_ VALUE	The value and status of the result of computing EQ10.
44	EQ11_ VALUE	The value and status of the result of computing EQ11.
45	EQ12_ VALUE	The value and status of the result of computing EQ12.
46	EQ13_ VALUE	The value and status of the result of computing EQ13.
47	EQ14_ VALUE	The value and status of the result of computing EQ14.
48	EQ15_ VALUE	The value and status of the result of computing EQ15.
49	EQ16_ VALUE	The value and status of the result of computing EQ16.
50	OUT1_ VALUE	The value and status of the result of computing OUT1_ EQ.
51	OUT2_ VALUE	The value and status of the result of computing OUT2_ EQ.
52	OUT3_ VALUE	The value and status of the result of computing OUT3_ EQ.
53	OUT4_ VALUE	The value and status of the result of computing OUT4_ EQ.
54	DO1_ VALUE	The value and status of value coming from channel DO1.
55	DO2_ VALUE	The value and status of value coming from channel DO2.
56	DO3_ VALUE	The value and status of value coming from channel DO3.
57	DO4_ VALUE	The value and status of value coming from channel DO4.
58	DO5_ VALUE	The value and status of value coming from channel DO5.
59	DO6_ VALUE	The value and status of value coming from channel DO6.
60	DO7_ VALUE	The value and status of value coming from channel DO7.
61	DO8_ VALUE	The value and status of value coming from channel DO8.
62	DETAILED_ STATUS	Indicates the state of the transmitter.

DISCRETE INPUT BLOCK

The DI takes the manufacturer's discrete input data, selected by channel number, and makes it available to other function blocks as its output. The output will have a value of either true or false along with the status of the output. A custom feature of the DI block in the 848L is the ability to pack 8 status bits into the single output of a DI block. This is accomplished by selecting the appropriate channel number for packed data. This feature is used in custom applications implemented in control systems such as DeltaV.

The DI block supports a function to invert the input and alarming.



848/848L/DISCRETE1.EPS

Table C-4. Parameters

Index	Parameter
1	ST_REV
2	TAG_DESC
3	STRATEGY
4	ALERT_KEY
5	MODE_BLK
6	BLOCK_ERR
7	PV_D
8	OUT_D
9	SIMULATE_D
10	XD_STATE
11	OUT_STATE
12	GRANT_DENY
13	IO_OPTS
14	STATUS_OPTS
15	CHANNEL
16	PV_FTIME
17	FIELD_VAL_D
18	UPDATE_EVT
19	BLOCK_ALM
20	ALARM_SUM
21	ACK_OPTION
22	DISC_PRI
23	DISC_LIM
24	DISC_ALM

DISCRETE OUTPUT BLOCK

The DO block makes the value sent in SP_D, CAS_IN_D, or RCAS_IN_D available for processing by the device. The CHANNEL selection determines where the value is stored in the 848L. A custom feature of the DO block in the 848L is the ability to accept 8 status bits packed into the single setpoint of a DO block. This is accomplished by selecting the appropriate channel number for packed data. This feature is used in custom applications implemented in control systems such as DeltaV.

The Invert I/O option can be used to do a Boolean NOT function on the setpoint value.

The SP_D supports the full cascade sub-function. Cas mode must be used to transfer the output of another block to the SP_D of the DO.

There are additional I/O options which will cause the SP_D value to track the PV_D value when the block is in an actual mode of LO or Man.

The 848L does not support a readback value in which case READBACK_D is generated from OUT_D. The OUT_D and READBACK_D parameters both use XD_STATE. The PV_D and SP_D use PV_STATE.

Supported Modes

O/S, LO, Iman, Man, Auto, Cas, and RCas. The Man mode can be used to force the output, in a PLC sense. It may be that Man mode is not permitted, but it must be supported so that Man mode may be entered when leaving O/S. The IMan mode is used to indicated that there is no path to the final element. IMAN is not used in the 848L.

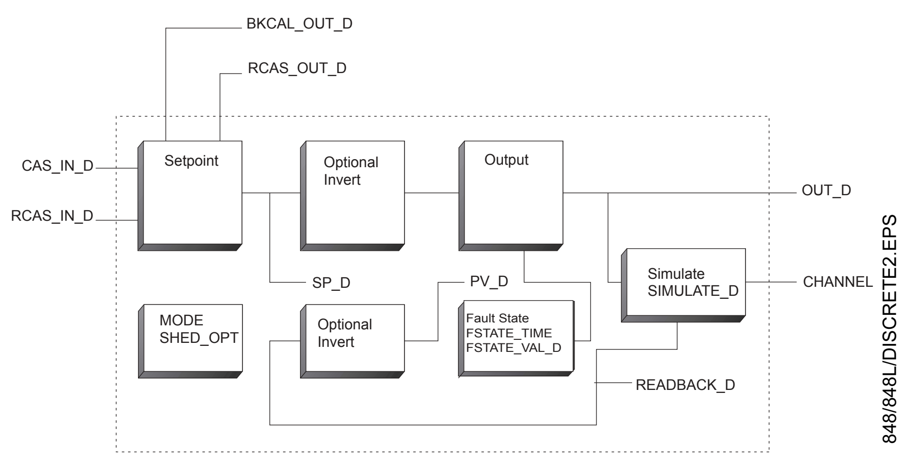


Table C-5. Parameters

Index	Parameter
1	ST_REV
2	TAG_DESC
3	STRATEGY
4	ALERT_KEY
5	MODE_BLK
6	BLOCK_ERR
7	PV_D
8	SP_D
9	OUT_D
10	SIMULATE_D
11	PV_STATE
12	XD_STATE
13	GRANT_DENY
14	IO_OPTS
15	STATUS_OPTS
16	READBACK_D
17	CAS_IN_D
18	CHANNEL
19	FSTATE_TIME
20	FSTATE_VAL_D
21	BKCAL_OUT_D
22	RCAS_OUT_D
23	SHED_OPT
24	RCAS_OUT_D
25	UPDATE_EVT
26	BLOCK_ALM

MULTIPLE DISCRETE INPUT BLOCKS

The MDI block makes available for the FF network eight discrete variables of the I/O subsystem through its eight output parameters OUT_D1/8 Status indication in the OUT_Dx output parameters depends on the I/O subsystem and the transducer block, that is manufacturer specific.

For example, if there is individual detection of sensor failure, it can be indicated in the status of related OUT_Dx parameter. A problem in the interface to the I/O subsystem can be indicated in the status of all OUT_Dx as BAD – Device Failure.

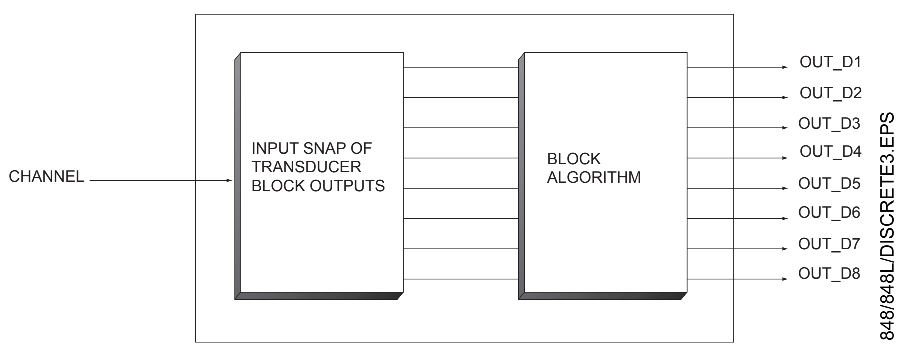


Table C-6. Parameters and Description

Index	Parameter	Description
1	ST_REV	The revision level of the static data associated with the function block.
2	TAG_DESC	The user description of the intended application of the block.
3	STRATEGY	The strategy field can be used to identify grouping of blocks.
4	ALERT_KEY	The identification number of the plant unit.
5	MODE_BLK	The actual, target, permitted, and normal modes of the block: Target: The mode to .go to. Actual: The mode the .block is currently in. Permitted: Allowed modes that target may take on Normal: Most common mode for actual
6	BLOCK_ERR	This parameter reflects the error status associated with the hardware or software components associated with a block. It is a bit string, so that multiple errors may be shown.
7	CHANNEL	The CHANNEL value is used to select the measurement value. Refer to the appropriate device manual for information about the specific channels available in each device. You must configure the CHANNEL parameter before you can configure the XD_SCALE parameter.
8	OUT_D1	Discrete output to indicate a selected alarm condition.
9	OUT_D2	Discrete output to indicate a selected alarm condition.
10	OUT_D3	Discrete output to indicate a selected alarm condition.
11	OUT_D4	Discrete output to indicate a selected alarm condition.
12	OUT_D5	Discrete output to indicate a selected alarm condition.
13	OUT_D6	Discrete output to indicate a selected alarm condition.
14	OUT_D7	Discrete output to indicate a selected alarm condition.
15	OUT_D8	Discrete output to indicate a selected alarm condition.
16	UPDATE_EVT	This alert is generated by any change to the static data.
17	BLOCK_ALM	The block alarm is used for all configuration, hardware, connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status parameter. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.

MULTIPLE DISCRETE OUTPUT BLOCK

The MDO block makes available to the I/O subsystem its eight input parameters IN_D1/8.

This function block keeps the fault state features specified for the DO block. It includes option to hold the last value or a preset value when in Fault State, individual preset values for each point, and a delay time to go into the Fault State.

The actual mode will be LO only due to the resource block (SET_FSTATE parameter). If an input parameter has a bad status, that parameter will be in Fault State, but the mode calculation of the block will not be affected.

The parameter FSTATE_STATUS shows that points are in Fault State.

The MDO block does not support back calculation, or the Cas mode.

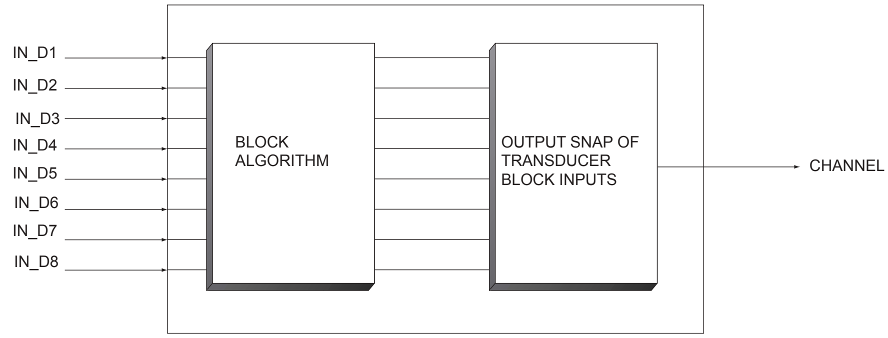


Table C-7. Parameters and Description

Index	Parameter
1	ST_REV
2	TAG_DESC
3	STRATEGY
4	ALERT_KEY
5	MODE_BLK
6	BLOCK_ERR
7	CHANNEL
8	IN_D1
9	IN_D2
10	IN_D3
11	IN_D4
12	IN_D5
13	IN_D6
14	IN_D7
15	IN_D8
16	MO_OPTS
17	FSTATE_TIME
18	FSTATE_VAL_D1
19	FSTATE_VAL_D2
20	FSTATE_VAL_D3
21	FSTATE_VAL_D4
22	FSTATE_VAL_D5
23	FSTATE_VAL_D6
24	FSTATE_VAL_D7
25	FSTATE_VAL_D8
26	FSTATE_STATUS
27	UPDATE_EVT
28	BLOCK_ALM

Appendix D Logic Equation Syntax

1. All lines shall end with a semi-colon.
2. Accepted characters shall be standard 7-bit ASCII characters from the list below:

- A-Z
- a-z
- 0-9
- , (comma)
- ( ) (parenthesis)
- (space)
- ; (semicolon)
- _ (underscore)

3. The maximum number of characters per equation shall be 80.
4. Function calls are in the form FUNC(PARAM1,PARAM2,...PARAMN) where FUNC is one of the supported functions in Table D-1 on page D-2, and PARAMx are expressions to be input to the function.
5. Function names must be one of the names listed in the table below.
6. All spaces shall be ignored except within function names and function parameters.
7. The parameters in a function call shall contain at least the required parameters shown in table 2, but no more than the maximum.
8. The number of times a function is used (totaled in all equations) must be less than or equal to the maximum number of instances allowed shown in Table D-1 on page D-2.
9. Each equation must evaluate to a single boolean value.

Table D-1. Supported Functions

Function Name	Required number of parameters	Maximum number of parameters	Function Description	Maximum Instances
AND	2	10	AND (a, b,...); This function's result will be the logical and of a, b,...	NO LIMIT
CLOCK	2	2	CLOCK (onTime, offTime); This function is a periodic clock. The result of this function will be true for 'onTime' * 100 milliseconds, then false for 'offTime' * 100 milliseconds, and repeats forever.	10
CTU	3	3	CTU (clock, reset, count); This function is an UP COUNTER. When 'reset' is true, this function will set its' internal counter to 0. When 'reset' is false, this function will increment its' internal counter each time 'clock' has a rising edge, until the counter reaches 'count'. The result of this function will be true when the counter reaches 'count', and false otherwise.	20
DO	1	1	DO (channel number); This function's result will be the value of the requested external channel value coming into this device via a DO function block.	NO LIMIT
EQ	1	1	EQ (channel number); This function's result will be the value of the requested equation result. *Note: The equation values are processed in order from the first equation to the last, so if equation 4 asks for equation 20 value, the equation 20 value will be the value calculated in the previous run time cycle.*	NO LIMIT
FALL	1	1	FALL (a); This function is a falling edge trigger. When 'a' transitions from true to false, this function's result is true, otherwise it is false.	10
ICF	1	1	ICF (channel number); This function's result will be true for one execution cycle, if the value of the requested device input has had at least one falling transition since the last execution cycle. This is ideal for capturing events that occur faster then the logic execution cycle.	NO LIMIT
ICR	1	1	ICR (channel number); This function's result will be true for one execution cycle, if the value of the requested device input has had at least one rising transition since the last execution cycle. This is ideal for capturing events that occur faster then the logic execution cycle.	NO LIMIT
IN	1	1	IN (channel number); This function's result will be the value of the requested device input.	NO LIMIT
NOT	1	1	NOT (a); This function's result will be the logical not of a.	NO LIMIT
OR	2	10	OR (a, b,...); This function's result will be the logical or of a, b,...	NO LIMIT
OUT	1	1	OUT (channel number); This function's result will be the value of the requested device output.	NO LIMIT

Table D-1. Supported Functions

Function Name	Required number of parameters	Maximum number of parameters	Function Description	Maximum Instances
PS	2	2	PS (channel number, divisor); This function is a frequency prescaler. This function's value will be true for 1 execution cycle each time the requested device input has had 'divisor' pulses. This is ideal for a scaling fast pulse inputs to a rate suitable for the logic execution cycle.	10
RISE	1	1	RISE (a); This function is a rising edge trigger. When 'a' transitions from false to true, this function's result is true, otherwise it is false.	10
RS	2	2	RS (set, reset); This function is a reset dominant latch. When 'reset' is true, this function will reset its' state to false regardless of the value of 'set'. When 'reset' is false, the function's state will have a false value until 'set' has had at least 1 true reading, after which the state will remain true. The result of this function is the function's state.	10
SHL	3	4	SHL (a, clock, reset, bit); This function is an 8 bit left shift register. When 'clock' transitions from false to true, the value of 'a' is shifted into the least significant bit of this function's register. The remaining bits are shifted left by 1 bit position. When 'reset' is true, all 8 bits in this function's register will be cleared to zero. 'reset' is an optional parameter and will always be considered false if it is not present. The result of this function is the value of bit number 'bit' in the register.	10
SHR	3	4	SHR (a, clock, reset, bit); This function is an 8 bit right shift register. When 'clock' transitions from false to true, the value of 'a' is shifted into the most significant bit of this function's register. The remaining bits are shifted right by 1 bit position. When 'reset' is true, all 8 bits in this function's register will be cleared to zero. 'reset' is an optional parameter and will always be considered false if it is not present. The result of this function is the value of bit number 'bit' in the register.	10
SR	2	2	SR (set, reset); This function is a set dominant latch. When 'set' is true, this function will set its' state to true regardless of the value of 'reset'. When 'reset' is false, the function's state will have a false value until 'set' has had at least 1 true reading, after which the state will remain true. When reset is true, the function's state will be set to the value of 'set'. The result of this function is the function's state.	10
TOF	2	2	TOF (a, time); This function is an off delay. When 'a' is true, this function will set its' output to true. When 'a' transitions to false, the function's output will remain true for 'time' * 100 milliseconds before going false.	10

Table D-1. Supported Functions

Function Name	Required number of parameters	Maximum number of parameters	Function Description	Maximum Instances
TON	2	2	TON (a, time); This function is an on delay. When 'a' is false, this function will set its' output to false. When 'a' transitions to true, the function's output will remain false for 'time' * 100 milliseconds before going true.	10
TP	2	2	TP (a, time); This function is a pulse timer. When 'a' transitions to true, this function will set its' output to true for 'time' * 100 milliseconds, and then return false.	10
XOR	2	10	XOR(a, b,...); This function is false if all parameters are in the same state, either all true or all false. Otherwise the function is true.	NO LIMIT

ERROR HANDLING

The syntax of the entered equation is parsed when the target mode transitions from OOS to AUTO. Each equation is checked in order, and when an error is encountered in an equation, the parsing is suspended for the remaining equations, and the target mode is set back to OOS. The equation where the problem was encountered is indicated along with a message as shown in the table below.

Bounds checking on the values of parameters used in the functions are checked during run-time when ACTUAL MODE is AUTO. Errors of this type will be indicated by a bad status in the equations computed value.

Table D-2. Error Handling

Conditions	Status response
No semi-colon appears in the equation.	Missing semi-colon.
More left parenthesis than right parenthesis.	Un-matched (.
More right parenthesis than left parenthesis.	Un-matched).
A comma placed without a preceding function parameter.	Badly placed comma.
Open and Closed parenthesis without a parameter or statement contained.	Empty ().
A semicolon is contained prior to finishing an expression.	Badly placed semicolon.
A function call is missing one or more parameters.	Too few parameters in function.
A bad character is present, or a parameter appears outside of a function call.	Syntax error.
An unknown function is called out.	Unknown function.
An opening parenthesis is located after the closing parenthesis of a function call.	Badly placed (.
A function call contains too many parameters.	Too many parameters in function.
A decimal number was found where an integer was expected.	Invalid number.
A function result was used as a function parameter where a literal integer number was expected.	Invalid parameters in function.
A function has been used more than the maximum allowed instances.	Insufficient resources.
All equations were parsed successfully.	Equation completed.

EXAMPLES

Take value of input 1 and put it on output 3.... Set OUT3_EQ to:

```
IN(1);
```

For every transition (in both directions) on input 5, send a 200 msec pulse out on output 2, but only if input 2 is low.... Set OUT2_EQ to:

```
AND(OR(TP(IN(5),2),TP(NOT(IN(5)),2)),NOT(IN(2)));
```

Turn on output 1 only after input 8 has gone high 10 times, start over counting when input 6 is set high.... Set OUT1_EQ to:

```
CTU(IN(8),IN(6),10);
```

Appendix E Motor Control

INTRODUCTION TO MOTOR CONTROL

Industrial motors require about a kilowatt per horsepower, usually delivered as three phase AC at 440 volts or higher. This requires a special switch to turn them on and off. The switch is called a contactor, in which a solenoid is energized to pull a set of three power contacts to close the circuit to turn the motor on. The contacts are large enough to carry the starting current without welding. They are separated by insulation suitable for the supply voltage. The solenoid is de-energized to turn the motor off. Springs quickly separate the contacts to prevent arc damage, which can be severe at higher voltages. A contactor for a 400 HP 2500 VAC motor may be housed in a steel box that is two feet square and five feet high.

The three phase wires to the motor go through three overload heaters. There are no contacts in this wiring, just heaters that mount on screw terminals. The same contactor may be used for different motor sizes by changing the heater overload rating. When an overload occurs, the heaters cause a contact to open that is in series with the contactor's solenoid, which removes power from the motor. (This action is called a "trip" because it is mechanically like tripping an alarm mechanism. Alarms are said to trip because the early electric bank alarms used a trip wire to detect a robber.) The trip is supposed to happen before the motor windings overheat and destroy their insulation. After things have cooled off and someone has removed the cause of the overload, a reset button must be pressed to close the heat triggered mechanical latch for the overload contact. This allows power to flow in the solenoid circuit again.

The solenoid runs at a lower voltage than the motor, called the control voltage. This voltage is taken from a transformer within the contactor enclosure that is connected to two of the supply wires. The circuit breaker for the contactor may be in another box somewhere. When the breaker is turned off (or trips) the contactor enclosure is electrically dead, even for the control voltage. The contactor's solenoid may run at a higher voltage to get enough power to move the contact assembly against its springs. A pilot relay is used to switch that voltage within the enclosure. The control voltage seldom exceeds 120 VAC or is less than 24 VAC. One side of the control voltage is always grounded. Both the overload mechanism and the pilot relays are now available in solid state form.

The enclosure containing the contactor, overload mechanism and control power supply may be called a motor starter. The contactor's solenoid or that of the pilot relay carrying control voltage may be called a coil, as in relay coil. A group of motor starters may be called a Motor Control Center (MCC).

The contactor is never controlled with a toggle switch, because that would leave one side of the solenoid electrically hot when the motor overload trips. Standard procedure calls for start and stop push buttons in combination with an auxiliary contact on the contactor. This contact closes when the solenoid is energized and the motor contacts close. The auxiliary contact is rated for the control voltage and current, and is far away from the high voltage motor contacts. The stop button is normally closed and is in series with the control power. The start button is normally open and is also in series with the control power. The auxiliary contact is normally open and in parallel with the start button. When the start button is pushed, the solenoid is powered and the motor and auxiliary contacts eventually close. The start button can be released and control power will continue to flow in the auxiliary contact. Two things can stop the motor. Pressing the stop button removes power to the solenoid, causing the auxiliary contact to eventually open along with the motor power contacts. The stop button can then be released because there is no complete circuit to the solenoid. The same thing happens if an overload trip opens the circuit to the solenoid. When the overload is reset, no power will be applied to the solenoid until the start button is pushed.

```
|  ___        ___                    Over  |
|  \_/STOP    \_/START               load  |
|   |          |                 M     |   |
+--O|O-----+--O O--+------------( )---O|O--+ Contactor M
|          |       |                       |
|          |   M   |                       |
|          +--| |--+                       |
```

VARIATIONS ON MOTOR CONTROL

Interlock

There may be a process condition where it is not safe to run the motor. If this condition can be detected and transformed into the change of state of a contact, then the normally closed contact may be inserted in series with the control voltage. If the interlocked condition occurs then the motor will not run or start. An example is a low level condition in a tank feeding the suction of a pump. The pump will be damaged if the suction goes dry, so a low level switch is put in series with the control voltage for the pump's motor starter.

Permissive

There may be a process condition that is required to be present when a motor is started, but is not required once the motor is running. A contact that is closed when the permissive condition is true is placed in series with the start button. An example is auxiliary lubrication for a large motor that is required to flood the bearing housings to prevent contact between the motor shaft and the bearing material (not ball bearings). Once the motor is turning, lubrication is maintained by shaft rotation and the auxiliary pump can be shut off.

Emergency Shutdown

A process may have an emergency shutdown requirement for all motors. This requires a contact or logic input for all affected motor controls. For example, there is an emergency stop button for a natural gas processing plant located near the exit, so that the operator can hit it while running away.

Restart Delay

A motor may be used in a condition where starting is difficult, causing the motor to heat rapidly until it gets running. That heat must be allowed to dissipate before the motor is started again. A simple time delay prevents the start button from working until a fixed delay time expires. Another example is the time required for compressor head pressure to bleed off after the compressor motor stops.

Maximum Restarts

Another way of handling difficult starts is to count the number of starts in a given time and lock out the start button if the count is exceeded. Locking it out means that the start button will not function until a latching relay has been manually reset by an operator who has verified the safety of the situation.

Winding temperature

The above restart limiters may not be necessary if the winding temperature can be measured and used as a permissive for starting. The winding temperature sensor may be a ten ohm length of copper wire that is wound into the motor along with the power windings.

Hand-Off-Auto

An operator may be required to perform some function near the motor, such as clean a pump strainer or jog the motor to get its load into the right position. The motor is normally controlled by the central system but must have a local station to allow the local operator to control the motor. The local station has buttons for Stop and Start, and a three position switch for Hand-Off-Auto (HOA) selection. The control room has control when the switch is in the Auto position. The motor will not run when the switch is in the Off position. The Hand position allows the local start and stop buttons to control the motor. The Off position is not as secure as the lockout procedure required when the equipment or the operator would be damaged if the motor started. This requires all concerned people to physically put a padlock on the Off position of the main circuit breaker for the motor. The motor may be started after the last person removes their lock.

Intermediate Stop

A reversible motor may be required to come to a complete stop before starting to run in the other direction. This may be done with a timer or a motion sensor on the motor (or driven load) shaft.

Redundant Motors

The process may require redundant motors for reliability. Usually this applies to pumps, so that there is no mechanical connection between the two motors. One pump may be shut off to replace seals (or the entire pump and motor) while the redundant pump maintains flow in the line. There are three ways to control redundant pumps:

Alternate Start

When the start button is pressed the pump that was not in use is started. Not in use refers to now or since the last time start was pressed.

Timed Switch

The pumps have a known life time within an acceptable risk, so one pump is allowed to run until that time expires. The other pump automatically takes over at that time.

Switch on Failure

If a process condition can be sensed that says the running pump failed, then the other pump is started regardless of the starting protocol.

WRITING 848L EQUATIONS

Basic Motor Control

It is not easy to convert a functional diagram to an 848L equation because all of the functions must be nested in the proper order. One way to begin the process is to draw the functional diagram in ladder logic. The following is a basic two button and auxiliary contact motor control that is drawn with channel numbers.

```
|                                                  |
|     1       2                             Out1   |
+--| |--+--||--+----------------------( )--+ OUT1_EQ
|       |      |                                   |
|       |   3  |                                   |
|       +--||--+                                   |
|                                                  |
```

Input 1 is from a normally closed stop button, which does not have to be inverted in the equation. This is true for all stop buttons in the following examples.

Input 2 is from the normally open start button and Input 3 is from the contactor's auxiliary contact.

The ladder coil shown is at Out1, which is the value of output equation 1. Wires from output 1 will switch power from the control voltage to the contactor's solenoid or pilot relay.

Since the 848L uses RPN, begin from the lowest line in the ladder diagram and work upwards.

The first expression is OR(IN(2),IN(3)) from "2 or 3" in the ladder diagram. This is one term in an AND function, so build the function around it.

The top and final expression is AND(IN(1),OR(IN(2),IN(3))) from "1 and (2 or 3)" in the ladder diagram.

Enter the expression as the contents of parameter OUT1_EQ in the logic transducer block. Do not forget to append the terminating semicolon.

Connect the buttons, auxiliary contact and contactor (a small relay will do) in order to test the operation.

Interlock

An interlock switch is easily added as follows, where input 4 is the normally closed interlock:

```
|                                                     |
|     1       2        4                      Out1    |
+--|  |--+--||--+--|/|-----------------( )--+  OUT1_EQ
|        |       |                                    |
|        |   3   |                                    |
|        +--||--+                                     |
|                                                     |
```

- The first expression is still OR(IN(2),IN(3))
- The top and final expression is now AND(IN(1),OR(IN(2),IN(3)),IN(4));

Enter the expression and test as above.

Permissive

A permissive switch may be added, with or without the interlock, as shown, where 5 is the permissive:

```
|                                                     |
|     1       2      5        4              Out1    |
+--|  |--+--||----||--+--|/|-----------( )--+  OUT1_EQ
|        |             |                              |
|        |   3         |                              |
|        +--||--------+                               |
|                                                     |
```

- The first expression is now AND(IN(2),IN(5))
- The second expression is OR(AND(IN(2),IN(5)),IN(3))
- The final expression is AND(IN(1),OR(AND(IN(2),IN(5)),IN(3)),IN(4));

Emergency Shutdown

In ladder logic, this would be shown as a switch for power to a section of the ladder if there was more than one thing to be turned off. In the 848L, one contact must be shown for each rung but only one input is required. The shutdown contact is input 8 in the drawing below:

```
|                                                     |
|     1       2      5        4       8      Out1    |
+--|  |--+--||----||--+--|/|----|/|----( )--+  OUT1_EQ
|        |             |                              |
|        |   3         |                              |
|        +--||--------+                               |
|                                                     |
```

- The first expression is still AND(IN(2),IN(5))
- The second expression is OR(AND(IN(2),IN(5)),IN(3))
- The final expression is AND(IN(1),OR(AND(IN(2),IN(5)),IN(3)),IN(4),IN(8));

Restart Delay

An off delay timer is required as a permissive for starting the motor. When the motor is started, the off delay contact opens the circuit for the start button and keeps it open for a specified time. The motor will be cooled as it runs, so the delay is only applied to the start. Motors that require this are usually large and have long cooling times, like 30 to 100 minutes.

```
|                                                   |
|   3                                           T   |
+--||--------------------------------------( )--+ EQ1
|                                                   |
|    1       2       T                     Out1 |
+--| |--+--||----|/|--+---------------( )--+ OUT1_EQ
|        |              |                           |
|        |   3          |                           |
|        +--||---------+                           |
|                                                   |
```

Channels 1, 2, and 3 are the same as for basic motor control. T is the off timer. Notice that this diagram depends on the order of execution of ladder rungs. EQ1 is executed before OUT1_EQ. The value of EQ1 is initially false because the motor is not running. The start button starts the motor. When the confirm contact closes, EQ1 becomes true and breaks the start circuit, but the confirm contact has closed and the motor stays running.

Each rung requires a separate equation in the 848L so that the execution order can be preserved. Note that the output equations are always executed last, so it is good practice to arrange the ladder diagram in execution order.

Rung T is equation 1. It generates a 60 minute pulse when the confirm contact is true.

- The expression is TP(IN(3), 36000);

For rung Out1, the expression is basic motor control with input 2 in series with T:

- The expression is AND(IN(1),OR(AND(IN(2),NOT(EQ(1))),IN(3)));

Maximum Restarts

A large motor is too expensive to replace if it burns up because the operator wanted to give it another try, when in fact the pump was jammed. The life of the contactor is also shortened when it has to interrupt locked rotor current. In this case, it is normally possible for the motor to clear the jam on the second or third try. A counter limits the number of starts to 3, for example, within a preset time since the first attempt.

Notice that C1 in EQ1 and T2 in EQ2 are forward references that cannot have a bad status. A Bad status at channel 2 (the start button) will propagate to all of the equations and make the output Bad. A bad stop button or confirm contact will only make the output Bad. The I/O transducer block parameter OUT_1_CONFIG.FAIL_SAFE defaults to Fail False, which will stop the motor on any bad input status, or it may be set to Fail Last Good, which will not allow the stop button to turn it off. You probably don't want to uses input devices with status for this application.

```
|                                         |
|   2        C1                       T1  |
+--||------|/|-----------------------( )--+ EQ1
|                                         |
|   T1                   +-----+       C  |
+--||--------------------|Count|------( )--+ EQ2
|   T2                   |     |          |
+--||--------------------|Reset|          |
|                        +-----+          |
|                                         |
|   C                                 T2  |
+--||--------------------------------( )--+ EQ3
|                                         |
|    1      T1                      Out1  |
+--| |--+--||--+---------------------( )--+ OUT1_EQ
|       |      |                          |
|       |   3  |                          |
|       +--||--+                          |
|                                         |
```

Rung T1 is equation 1. The pulse time must be set to the allowable on time for the locked rotor condition to prevent tripping the overloads, in this case 2.5 seconds.

- The expression is TP(AND(IN(2),NOT(EQ(2))), 25);

Rung C is equation 2, which counts the attempts to start, and holds at the count until the 30 minute timer expires.

- The expression is CTU(RISE(EQ(1)),EQ(5), 3);

Rung T2 is equation 3, the 30 minute timer:

- The expression is TON(EQ(2),18000);

Rung Out1 is output equation 1:

- The expression is AND(IN(1),OR(EQ(1),IN(3)));

Winding Temperature

The multi-rung delay mechanism above may be replaced if the motor has a winding temperature sensor and a convertor that opens a contact when the motor is too hot and closes when it is sufficiently cool. The following drawing applies such a contact (as input 4) to the Restart Delay diagram, which reduces it to a permissive circuit.

```
|                                                 |
|     1       2       4                    Out1 |
+--| |--+--||----||--+----------------( )--+ OUT1_EQ
|        |             |                          |
|        |    3        |                          |
|        +--||---------+                          |
|                                                 |
```

The equations for a permissive circuit have already been described.

- The expression is AND(IN(1),OR(AND(IN(2),IN(4)),IN(3));

NOTE
This is not an interlock for high winding temperature. That is taken care of by the overloads. The purpose of this circuit is to prevent starting if the motor is too hot, such that the heat generated by starting would exceed the temperature rating of the motor. When the motor starts, the temperature will rise and open the safe temperature contact. This will happen after the auxiliary contact has closed, so the motor will continue to run. As it runs, it is cooled by an internal fan and eventually the safe temperature contact closes. An interlock could be added, but the temperature would have to be set much higher than the safe restart temperature.

Hand-Off-Auto

The HOA switch has one contact that is closed in the Hand position (input 1) and one contact that is closed in the Auto position (input 2). Both contacts are open in the Off position. The local hand controls are Stop (input 3) and Start (input 4). These require the auxiliary contact on the starter (input 5). Auto control is done in some DCS function blocks that generate a Run signal which is linked over an H1 fieldbus to a DO block in the 848L. This is the equivalent of a toggle switch, so the 848L logic breaks it up into start and stop signals. A pulse timer is required to extend the rise of the DCS Run signal until the confirm contact can pull in. An operator will hold the start button in until something happens. The DCS logic needs to know when the HOA switch is in the Auto position and also the state of the auxiliary contact, so DI blocks are configured for them. The ladder diagram looks like this:

```
|                                          |
|   DO1       5                          T |
+--|^|-----|/|------------------------( )--+ EQ1
|                                          |
|                                          |
|   1       3      4                  Out1 |
+--||-----| |--+--||--+------+--------( )--+ OUT1_EQ
|              |      |      |             |
|              |   5  |      |             |
|              +--||--+      |             |
|                            |             |
|                            |             |
|   2      DO1     T         |             |
+--||------||--+--||--+------+             |
|              |      |                    |
|              |   5  |                    |
|              +--||--+                    |
|                                          |
```

First, instantiate two DI blocks and a DO block. Set the DO channel to 9. Set the Auto DI channel to 2 and the Contactor DI channel to 5. Use appropriate configuration for the other data in the blocks, such as Tag.

Rung T is equation 1. This is necessary because the Out1 equation has 70 characters, not because it is needed in two or more equations.

- The expression is TP(AND(RISE(DO(1)), NOT(IN(5))),30);

Rung Out1 is output equation 1. The first expression and the second are basic motor control expressions with an additional selector contact.

- The expression is
  OR(AND(IN(1),IN(3),OR(IN(4),IN(5))),AND(IN(2),DO(1),
  OR(EQ(4),IN(5))));

To test this, use the usual buttons and relay along with a selector switch and manual operation of the DO block.

Intermediate Stop

A reversible motor requires two contactors. One of them swaps two of the motor wires so that it will run in the opposite direction. The contactors must never be closed at the same time, because that would place a short circuit across one of the three phases. Furthermore, motors with lots of attached or internal inertia can be damaged if the shaft does not come to rest before starting up in the other direction. Sometimes a brake is used to reduce the stopping time. The Forward/Reverse selector switch has one contact that is closed in the Forward position (input 1) and one contact that is closed in the Reverse position (input 2). The center of the three position selector is Off. The push button controls are Stop (input 3) and Start (input 4). These require the auxiliary contact on each starter (input 5 and 6). A 30 second off delay timer is used. The following ladder diagram shows one way of doing this:

```
|                                             |
|    5                                    T   |
+--||--+------------------------------( )--+ EQ1
|      |                                      |
|    6 |                                      |
+--||--+                                      |
|                                             |
|    1       3       4      T       Out2  Out1 |
+--||-----|  |--+--||---|/|--+--|/|----( )--+ OUT1_EQ
|               |            |                |
|               |    5       |                |
|               +--||--------+                |
|                                             |
|                                             |
|    2       3       4      T       Out1  Out2 |
+--||-----|  |--+--||---|/|--+--|/|----( )--+ OUT2_EQ
|               |            |                |
|               |    6       |                |
|               +--||--------+                |
|                                             |
|                                             |
```

Rung T is equation 1. It is necessary because it is needed in two equations and because the equations would be 80 characters long without the semicolon.

- The expression is TOF(OR(IN(5),IN(6)),300);

Rung Out1 is output equation 1. This is basic motor control with additional contacts.

- The expression is AND(IN(1),IN(3),OR(AND(IN(4),NOT(EQ(1)),IN(5)),NOT(OUT(2));

Rung Out2 is output equation 2. This is also basic motor control with additional contacts.

- The expression is AND(IN(2),IN(3),OR(AND(IN(4),NOT(EQ(1)),IN(6)),NOT(OUT(1));

If a brake was required, it could be controlled by output equation 3:

- The expression is AND(EQ(1), NOT(IN(5)),NOT(IN(6)));

This simulation requires two relays in addition to the switches.

Redundant Motors - Alternate Start

Two motors drive two pumps in a redundant configuration. The control valve that follows the pumps will just waste the energy of the second pump, possibly damaging the valve, if both pumps on at the same time. There are times when neither pump is required. When a pump is required, the pump that was not in use last time should be started to equalize the wear on the pumps. The push button controls are Stop (input 1) and Start (input 2). An auxiliary contact is required from each starter (inputs 3 and 4).

```
|                                          |
|    3      4      2                    P  |
+--|/|----|/|-----|^|-----------------( )--+ EQ1
|                                          |
|   P       L           +-----+         L  |
+--||-----|/|------------|Set  |------( )--+ EQ2
|   P       L           |     |            |
+--||-----| |------------|Reset|            |
|                       +-----+            |
|                                          |
|           1      2       L    Out2  Out1 |
+---------| |--+--||--+--|/|---|/|----( )--+ OUT1_EQ
|              |   3  |                    |
|              +--||--+                    |
|                                          |
|                                          |
|           1      2       L    Out1  Out2 |
+---------| |--+--||--+--| |---|/|----( )--+ OUT2_EQ
|              |   4  |                    |
|              +--||--+                    |
|                                          |
```

Rung P is equation 1. It generates the pulse that will toggle the latch. The pulse comes from the RISE function.

- The expression is AND(NOT(IN(3)),NOT(IN(4)),RISE(IN(2)));

Rung L is equation 2. It latches on when L was false and unlatches when L was true.

- The expression is RS(AND(EQ(1),NOT(EQ(2)),AND(EQ(1),EQ(2)));

Rung Out1 is output equation 1. This is basic motor control with additional contacts.

- The expression is AND(IN(1),OR(IN(2),IN(3)),NOT(EQ(2)),NOT(OUT(2)));

Rung Out2 is output equation 2. This is also basic motor control with additional contacts.

- The expression is AND(IN(1),OR(IN(2),IN(4)),EQ(2),NOT(OUT(1)));

Redundant Motors - Timed Switch

Again, redundant pumps are used but only one pump runs at a time. The process runs for years without being shut down. The switch between pumps occurs at a time near the end of the useful life of the pump, usually several thousand hours. Stopping the old pump is delayed by a TOF while the other pump comes up to speed, which the control valve can handle. The push button controls are Stop (input 1) and Start (input 2). An auxiliary contact is required from each starter (inputs 3 and 4). The life time is measured in thousands of hours, so an external retentive timer with a display is used. Timing power comes from Out2, reset power from Out1 and the timed out contact comes in at channel 5.

Actually, this scheme is not practical unless the latches are non-volatile.

```
|                                          |
|    2                   +-----+       L1  |
+--| |-------------------|Set  |------( )--+ EQ1
|    1                   |     |           |
+--|/|-------------------|Reset|           |
|                        +-----+           |
|    5                                 P1  |
+--|^|--------------------------------( )--+ EQ2
|                                          |
|   P1      L2           +-----+       L2  |
+--| |----|/|------------|Set  |------( )--+ EQ3
|   P1      L2           |     |           |
+--| |----| |------------|Reset|           |
|                        +-----+           |
|   L1                                Out1 |
+--|^|--+-----------------------------( )--+ OUT1_EQ
|       |                                  |
|   P1  |                                  |
+--| |--+                                  |
|                                          |
|   3      Out1                       Out2 |
+--| |--+--|/|------------------------( )--+ OUT2_EQ
|       |                                  |
|   4   |                                  |
+--| |--+                                  |
|                                          |
|   L1     L2     Out1                Out3 |
+--| |----|/|--+--| |--+--------------( )--+ OUT3_EQ
|              |       |                   |
|              |   3   |                   |
|              +--| |--+                   |
|                                          |
|   L1     L2     Out1                Out4 |
+--| |----| |--+--| |--+--------------( )--+ OUT4_EQ
|              |       |                   |
|              |   4   |                   |
|              +--| |--+                   |
|                                          |
```

Rung L1 is equation 1. It latches on when the start button is true and unlatches when the NC stop button is pushed. The latch remembers start and stop commands to simplify the logic.

- The expression is RS(IN(2),NOT(IN(1)));

Rung P1 is equation 2, which generates a pulse from one read of channel 5:

- The expression is TON(AND(OR(IN(3),IN(4)),NOT(EQ(2))),30000);

Rung L2 is equation 3. The latch determines which motor to start and run. It toggles when the life time is reached. That stops the running motor (after its off delay) and enables the other motor to be started.

- The expression is RS(AND(EQ(2),NOT(EQ(3)),AND(EQ(2),EQ(3)));

Rung Out1 is output equation 1. A timed start pulse is delivered to both motor circuits when either the start button is pressed to set the Run latch or the end of the hour count toggles the selector latch. Only the enabled circuit will start. The output resets the external timer.

- The expression is TP(OR(RISE(EQ(1)),EQ(2)),20);

Rung Out2 is output equation 2. Power goes to the external timer while either confirm is true, but not during reset.

- The expression is AND(OR(IN(3),IN(4)),NOT(OUT(1)));

Rung Out3 is output equation 3. This is basic motor control with an off delay of 5 seconds to maintain flow.

- The expression is TOF(AND(EQ(1),NOT(EQ(3)),OR(OUT(1),IN(3)),50);

Rung Out4 is output equation 4. This is also basic motor control with an off delay.

- The expression is TOF(AND(EQ(1),EQ(3),OR(OUT(1),IN(4)),50);

Redundant Motors - Switch on Failure

Again, there are redundant pumps. There is a pressure switch in the common discharge line. If the pressure falls then the other pump is started. If the pressure does not recover, possibly because a flammable liquid is pouring on the ground from a broken pump housing, then the alternate pump is stopped. The push button controls are Stop (input 1) and Start (input 2). An auxiliary contact is required from each starter (inputs 3 and 4). The pressure switch is linked into a DO that is true when the pressure is low.

```
|                                                      |
|     3       4       2    +-----+       L1   |
+--|/|-----|/|-----| |---|Set  |------( )--+ EQ1
|     1                    |     |            |
+--|/|--+----------------|Reset|            |
|     T  |                 +-----+            |
+--| |--+                                      |
|                                              |
|    DO                                  P    |
+--|^|--+-----------------------------( )--+ EQ2
|    L1  |                                    |
+--|^|--+                                      |
|                                              |
|    DO      L1                          T    |
+--| |-----| |------------------------( )--+ EQ4
|                                              |
|    P       L2            +-----+       L2   |
+--|^|----|/|------------|Set  |------( )--+ EQ4
|    P       L2            |     |            |
+--|^|----| |------------|Reset|            |
|                          +-----+            |
|                                              |
|           L1      P       L2   Out2  Out1 |
+---------| |--+--||--+--|/|---|/|----( )--+ OUT1_EQ
|               |   3  |                     |
|               +--||--+                     |
|                                              |
|           L1      P       L2   Out1  Out2 |
+---------| |--+--||--+--| |---|/|----( )--+ OUT2_EQ
|               |   4  |                     |
|               +--||--+                     |
|                                              |
```

Instantiate a DO block and set the channel number to 9.

Rung L1 is equation 1. It latches on when the start button is true and neither motor is running. It unlatches when the NC stop button is pushed or the pressure stays low for too long.

- The expression is RS(AND(NOT(IN(3)), NOT(IN(4)),IN(2)),OR(NOT(IN(1)),EQ(3));

Rung P is equation 2, which generates a 2 second start pulse from the rise of the run latch or the rise of the low pressure condition. This pulse toggles the latch and starts the selected motor.

- The expression is TP(OR(RISE(DO(1)),RISE(EQ(1))),20);

Rung T is equation 3, which is a TON that is run by the on state of the low pressure and the run latch.

- The expression is TON(AND(DO(1),EQ(1)),100);

Rung L2 is equation 4. The latch determines which motor to start and run. It toggles when equation 2 generates a pulse. The pulse duration is more than one evaluation cycle, so rise functions are required.

- The expression is RS(AND(RISE(EQ(2)),NOT(EQ(4))),AND(RISE(EQ(2)),EQ(4)));

Rung Out1 is output equation 1. This is basic alternate motor control.

- The expression is AND(EQ(1),OR(EQ(2),IN(3)),NOT(EQ(4)),NOT(OUT(2)));

Rung Out2 is output equation 2. This is also basic alternate motor control.

- The expression is AND(EQ(1),OR(EQ(2),IN(4)),EQ(4),NOT(OUT(1)));

Appendix F Valve Control

INTRODUCTION TO VALVE CONTROL

Industrial valves have two general classifications, regulating and block. A regulating valve is designed to be stable at any one of a nearly infinite set of positions between open and closed. They are mostly used in control loops so that nonlinearity and friction are corrected by feedback control. A block valve is designed to be either tight shut or wide open. They are mostly used to change the configuration of process equipment, such as a heat exchanger that can be used to heat or cool, but not both at the same time. Block valves configure steam in and condensate out for heating or chilled brine in and return for cooling. Regulating valves are being used as block valves when the actual position of the valve must be known, but analog outputs are used.

Block valves generally have some kind of switch that is closed in the open position and another switch for the closed position. These are called *confirm contacts* even if they are proximity switches. The valve position is unknown when neither switch is closed. If the valve actuator has adequate power then it is rare to find both switches open, except for a period of time known as the *travel time* when the valve is moving from one position to the other. Actuators can be hydraulic pistons, pneumatic pistons or diaphragms, or motor driven screws, in order of increasing travel time. More than 80% of the actuators use compressed, oil and water free air for power. Valves are referred to as air to open or air to close.

A block valve may be controlled by push buttons or by a toggle switch. There is no contactor as there is for a motor. Permissive and interlock circuits may be applied. The actuator may require power to be applied to open it, with a spring to return it to the closed position, or vice-versa. A block valve may be required to stay in its last position on air or power failure, so there is one pilot actuator to open it and another pilot actuator to close it. The pilot actuator is not usually designed for continuous power, so a few second pulse may be all that is required. The actuator is called a pilot because it just directs the flow of fluid power, as by pushing a spool valve from one side to the other. The spool valve directs the main flow to one side of the main actuator or the other, like the pilot valve in a power steering system. Two pilot solenoid valves are required if the spool latches in position, or one if the spool has a spring return.

There are at least three permutations of any valve circuit:

1. Steady or pulse output to the pilot solenoid (or whatever, piezoelectric bars are in use). Steady requires one output, pulse requires two.
2. Confirmed position switches for open, closed or both, using one or two inputs.
3. Automatic control or a local selector for Open-Auto-Close using no or two inputs (these are not common).

Interlock and permissive may be additional permutations.

Alarms

If a valve has one or both position switches then it is possible to alert the operator to the fact that the valve is not where it should be. This is not a permuted choice because the main reason for having position switches is to alarm this condition. It is not a simple alarm because time must be allowed for the valve to complete its stroke after it receives a command. An On Delay timer set for the travel time is required.

All numbers in 848L equations are examples. The user will want to change them.

Variations on Valve Control

Interlock

There may be a process condition where it is not safe to open the valve. If this condition can be detected and transformed into the change of state of a contact, then the normally closed contact may be inserted in series with the control output. If the interlocked condition occurs then the valve will close if open or stay closed. An example is the drain valve of a batch reactor, which may have two interlocks. One prevents opening the drain if any feed valve is open. The other will not let material in the reactor drain into a tank that isn't ready for it.

Permissive

There may be a process condition that is required to be present when a valve is opened, but is not required once it has been opened. A contact that is closed when the permissive condition is true is placed in series with the open command. A latch is required because the permissive may go false after the valve is opened. One application for a permissive involves a gas storage tank. The pressure must be above a certain amount to allow the valve to be opened, but once opened, the pressure will fall below the permissive level.

Open-Auto-Close

An operator may be required to perform some function near the valve, such as unplugging a pipe or locally directing material flow. The valve is normally controlled by the central system but must have a local station to allow the local operator to control it. The local station has a three position switch for Open-Auto-Close selection. The control room has control when the switch is in the Auto position. If the switch is turned to Open then the valve will open, possibly bypassing interlocks, and the same for Close. There is no *bump* going through Auto because the command is either Open or Close.

Double Block and Bleed

If the valve absolutely must not leak into the process, then two valves are put in series and the short pipe between them is vented (bled) to an appropriate place. The bleed valve must be shut before the main valves can be opened, and the main valves must both be closed before the bleed valve can be opened.

Motorized Valve

The actuator is a reversible motor that turns a lead screw that moves the valve stem. Two confirms are required because the motor is only free to turn while the valve stem is travelling. Outputs are required for the Forward and Reverse motor directions. If a big motor-driven valve takes a minute to change position, that's a long time to find out that it didn't move. The *crack time* is a period of time in which the previously closed contact must open, to confirm that the actuator is moving and the valve is not stuck or powerless.

Heat Exchange Medium Selection

Batch heat exchangers have to use different media to heat and cool. If the media are compatible, like steam and chilled water, then a simple four valve manifold can handle the selection. The four valves are independent because it is necessary to drain one medium from the exchanger before using the other. There are many variations on this theme, for incompatible media or more than two choices.

Boolean Expressions

The motor control descriptions used ladder logic. Another method that takes less room on the back of an envelope is the Boolean expression. The following is a comparison of Boolean and ladder operators (math operators are +,-,*,/). Only three operators are used in the examples:

```
   IN2                                        S2
--|/|--     = !IN2      ! is NOT      --+--||--+--
                                        |       |
  Q5  C7                                |  S3   |  = S2 | S3   | is OR
--||--||--  = Q5 & C7   & is AND        +--||--+
```

Functions are the same as 848L functions. The examples use TON, TOF and TP.

Basic Valve Control

Since very few applications exist for local valve control that are more than a simple toggle switch (electric or pneumatic), all examples use a DO block to take a command from Fieldbus. The DO point is on for open and off for close in all cases.

Open-Auto-Close

Those applications that use a local switch with automatic control have a three position switch arranged as Open-Auto-Close. Inputs 1 and 2 are used for confirms, so input 3 is used for Open and input 4 for Closed. No input is required for Auto.

- The Boolean expression is:
- The 848L expression is:
- EQ1 contains OR(AND(NOT(IN(4)),DO(1)),IN(3));

Alarm Variations

If there is just one close confirm on input 2, then the Boolean expression is:
ALARM = TON ((!DO1 & !IN2) | (DO1 & IN2), TravelTime)

If there is just one open confirm on input 1, then the Boolean expression is:
ALARM = TON ((DO1 & !IN1) | (!DO1 & IN1), TravelTime)

It both confirms are used, then the Boolean expression is:
ALARM = TON ((!DO1 & !IN2) | (DO1 & !IN1) | (IN1 & IN2), TravelTime)

The equivalent 848L expressions are:

TON(OR(AND(NOT(DO(1)),NOT(IN(2))),AND(DO(1),IN(2))),100);

TON(OR(AND(DO(1),NOT(IN(1)),AND(NOT(DO(1)),IN(1))),110);

TON(OR(AND(NOT(DO(1)),NOT(IN(2))),AND(DO(1),NOT(IN(1)),AND(IN(1),IN(2))),120);

The chosen expression goes in the last expression used, which must be linked to a DI to generate an alarm.

Output Variations

A valve actuator may be spring return, requiring one output, or bistable, requiring two outputs. Output 1 is used for Open and output 2 for Close. Bistable valves often require a short pulse instead of maintained power. The 848L expressions for spring return are:
OUT1 contains DO(1);

or bistable has:
OUT1 contains TP(DO(1),30);
OUT2 contains TP(NOT(DO(1)),30);

Output with Interlock

The interlock may be wired, or internal, or from the bus.
The example uses a DO from the bus:
OUT1 contains TP(AND(DO(1),DO(3)),30); spring return is AND(DO(1),DO(3));
OUT2 contains TP(OR(NOT(DO(1)),NOT(DO(3))),30);

Simple Valve Variations

A spring return valve with one close confirm:
EQ1 contains
TON(OR(AND(NOT(DO(1)),NOT(IN(2))),AND(DO(1),IN(2))),100);

OUT1 contains DO(1);

The fourth similar spring return valve in the same 848L:
EQ4 contains
TON(OR(AND(NOT(DO(4),NOT(IN(8))),AND(DO(4),IN(8))),100);

OUT4 contains DO(4);

A bistable valve with both confirms and a local station:
EQ1 contains OR(AND(NOT(IN(4)),DO(1)),IN(3));

EQ2 contains

TON(OR(AND(NOT(DO(1)),NOT(IN(2))),AND(DO(1),NOT(IN(1)),AND(IN(1),IN(2))),120);

OUT1 contains TP(DO(1),30);

OUT2 contains TP(NOT(DO(1)),30);

The second similar bistable valve in the same 848L:
EQ3 contains OR(AND(NOT(IN(8)),DO(2)),IN(7));

EQ4 contains

TON(OR(AND(NOT(DO(2)),NOT(IN(6))),AND(DO(2),NOT(IN(5)),AND(IN(5),IN(6))),120);

OUT3 contains TP(DO(2),30);

OUT4 contains TP(NOT(DO(2)),30);

Permissive

The permissive may be wired, or internal, or from the bus. The example uses DO3 from the bus. The confirmed open switch is used to hold the valve open if the permissive goes away. If the valve is spring return:
OUT1 contains AND(DO(1),OR(DO(3),IN(1)));

A bistable valve does not need a latch:
OUT1 contains TP(AND(DO(1),DO(3)),30);

OUT2 contains TP(NOT(DO(1)),30);

Either way, the alarm equation for just the open confirm is:
TON(OR(AND(DO(1),NOT(IN(1)),AND(NOT(DO(1)),IN(1))),110);

The alarm equation for both confirms is:
TON(OR(AND(NOT(DO(1)),NOT(IN(2))),AND(DO(1),NOT(IN(1)),AND(IN(1),IN(2))),120);

Double Block and Bleed

Certain materials must not leak through a valve that is supposed to be shut. Three valves are arranged in a leak-proof configuration as shown:

```
              V1            V2
In ----|><|----+----|><|---- Out
               |
               |    V3
               +--|><|-- Bleed
```

848L/DOUBLEBLOCK.TIF

All three valves are spring return. V1 and V2 return to closed, V3 returns to open. All 3 valves must have closed confirm switches, which allows two instances per 848L. If open confirms are also used, the alarm logic is different and only one instance per 848L is possible. V1 and V2 must both confirm closed in order to open the bleed valve by removing power to it. V3 must be closed (powered) to allow V1 and V2 to open. Since V1 and V2 operate together, they are both powered by the same output. The second output operates V3. The close confirms take inputs of the same number as the valve. A second instance takes inputs of the same number as the valve plus four. Open confirms take inputs of the same number as the valve plus three. DO1 is still the open/close command.

The outputs are the same whether or not there are open confirms.

OUT1 contains AND(DO(1),IN(3));

OUT2 contains NOT(AND(NOT(DO(1)),IN(1),IN(2)));

For single closed confirms, the valve assembly is confirmed open if V1 and V2 do not confirm closed and V3 confirms closed. The assembly is confirmed closed if V1 and V2 confirm closed and V3 does not confirm closed. The alarm is true if any of these conditions is false after the travel time has expired. The equation will not fit on one line, so two must be used:

EQ1 contains AND(NOT(DO(1)),OR(NOT(IN(1)),NOT(IN(2)),IN(3)));

EQ2 contains
TON(OR(AND(DO(1),OR(IN(1),IN(2),NOT(IN(3))),EQ(1)),110);

For both confirms, the valve assembly is confirmed closed if V1 and V2 confirm closed and V3 confirms open. The assembly is confirmed open if V1 and V2 confirm open and V3 confirms closed.

EQ1 contains AND(NOT(DO(1)),NOT(AND(IN(1),IN(2),IN(6))));

EQ2 contains
TON(OR(AND(DO(1),NOT(AND(IN(4),IN(5),IN(3)))),EQ(1)),140);

Motorized Valve

The motor runs forward to open the valve and reverse to close it. When the motor is off, the valve cannot move. Both confirms are required. Output 1 causes the motor to run forward, Output 2 is reverse. Only one output must be active at a time. Input 1 confirms that the valve is open and input 2 confirms closed.

OUT1 contains AND(DO(1),NOT(IN(1)),NOT(EQ(2)));

OUT2 contains AND(NOT(DO(1)),NOT(IN(2)),NOT(EQ(2)));

The alarm interacts with the motor drive so that power is not applied after the travel time expires. This prevents burnout of small motors that do not have a motor starter. A crack time alarm is also used in case the valve is stuck. Since this works even for small motors, there is no point to making it optional. The crack time is 5 seconds in this example and the travel time is 30 seconds.

EQ1 contains TON(OR(AND(IN(1),IN(2)),AND(DO(1),IN(2)),AND(NOT(DO(1)),IN(2))),50);

EQ2 contains OR(TON(OR(AND(NOT(DO(1)),NOT(IN(2))),AND(DO(1),NOT(IN(1))),300),EQ(1));

Heat Exchange Medium Selection

The media are steam and chilled water. DO1 is on to select heating with steam and off to select cooling with water. All four valves have both confirms, as follows:

Valve	Output	Opened	Closed
Steam In	Out1	In1	In5
Steam Out	Out2	In2	In6
Water In	Out3	In3	In7
Water Out	Out4	In4	In8

Steam condensate must drain and both steam valves be closed before the water valves are opened. The water must drain and both water valves be closed before the steam valves are opened. There is a steam trap after the steam outlet valve to prevent steam from blowing through the heat exchanger. The opening of the steam outlet valve is delayed to allow some condensate to form in the exchanger for proper operation of the trap.

OUT1 contains AND(DO(1),IN(7),IN(8));

OUT2 contains TOF(TON(OUT(1), 1200),1800);

OUT3 contains AND(NOT(DO(1)),IN(5),IN(6));

OUT4 contains TOF(OUT(3),1600);

Heating is confirmed if In1 and In2 and In7 and In8 are on. Travel time must include the water drain delay time and the steam outlet opening delay. Cooling is confirmed if In3 and In4 and In5 and In6 are on. Travel time must include the steam drain delay time.

EQ1 contains TON(AND(NOT(DO(1)),NOT(AND(IN(3),IN(4),IN(5),IN(6)))),1900);

EQ2 contains OR(TON(AND(DO(1),NOT(AND(IN(1),IN(2),IN(7),IN(8))),2900),EQ(1));

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